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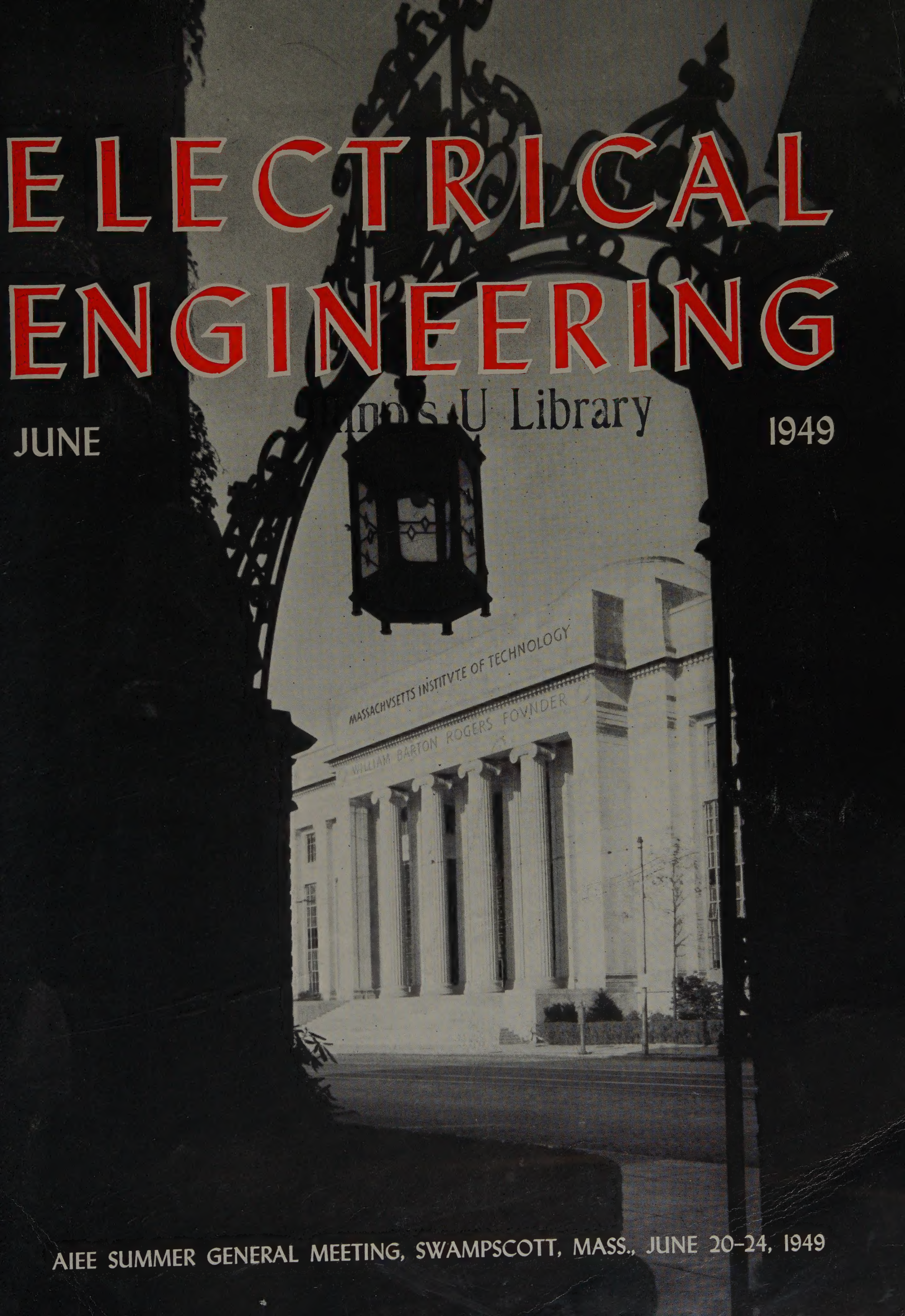
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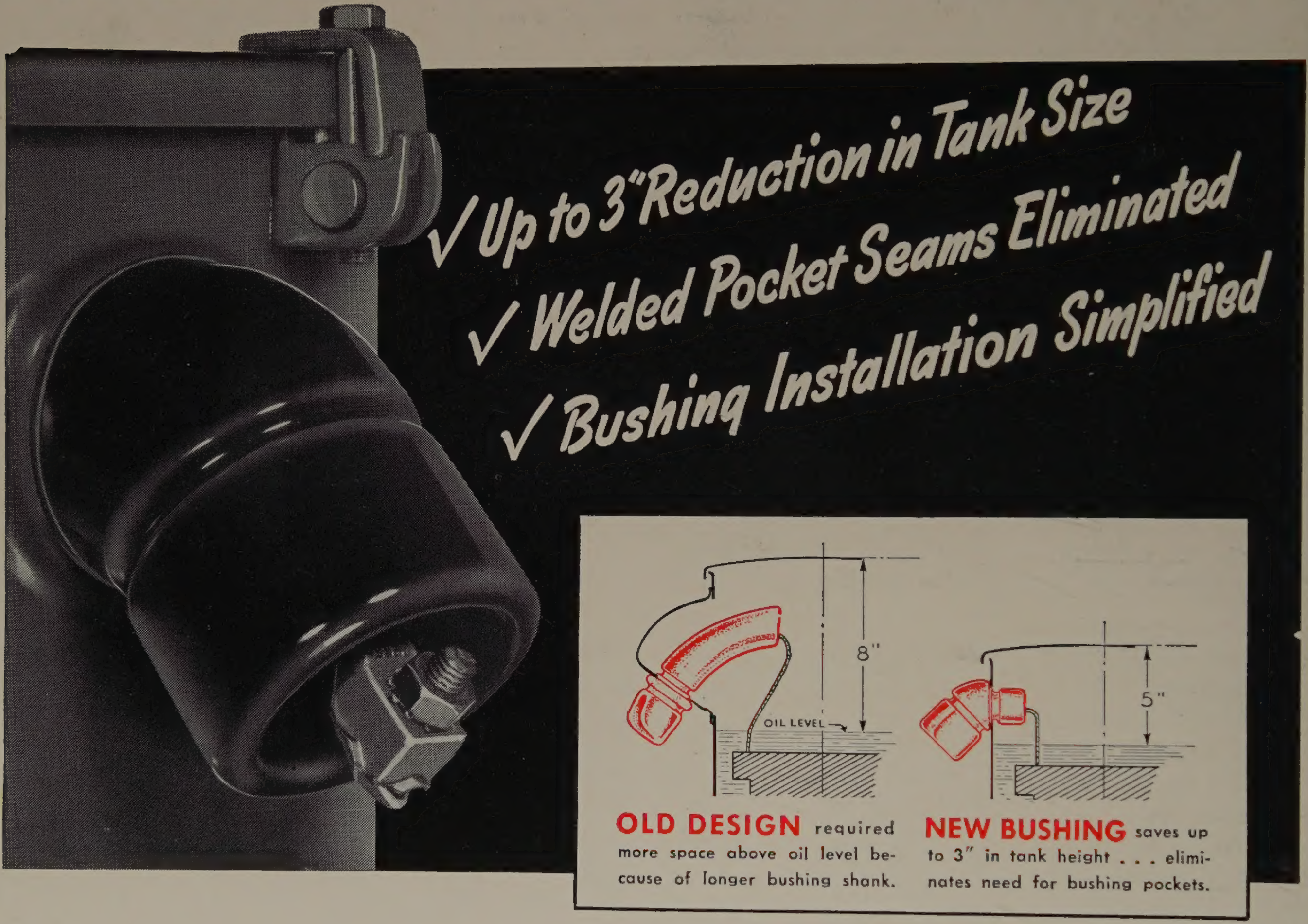
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Advances in the Theory of Ferromagnetism

R. M. BOZORTH

AMONG the most important developments in magnetic theory that have occurred during the last few years, three have been chosen for discussion. Each of these is associated closely with experimental work that has been carried out hand-in-hand with the theory. The items are

1. Domain structure and domain geometry.
2. Fine particles with high coercive force.
3. Ferromagnetic resonance at microwave frequencies.

Each will be discussed in turn.

DOMAIN THEORY

The basic idea of the domain theory is illustrated in Figure 1*a*. According to this idea, a ferromagnetic material is composed of small regions, or domains, each magnetized to saturation. The directions of magnetization, however, differ from domain to domain so that the net magnetization is zero when no external field is applied. The effect of the applied field is to change the direction of magnetization in the separate domains, and the body as a whole becomes magnetized in the way described by the well-known magnetization curve.

This article presents the results of the most recent investigations in the field of ferromagnetism. There have been a number of new ideas brought forth through research along these lines, of which three of the most outstanding ones are herewith explained and illustrated.

A second idea fundamental to domain theory is that, in the absence of a field, each domain will be magnetized in some one of a limited number of directions in the crystal. In iron, for example, which has a cubic crystal structure, each of the six directions of the cube axes is a direction of "easy" magnetization; and as shown in Figure 1*b* the magnetizations in the various domains of an unmagnetized material are distributed equally among the six directions.

These figures are simply schematic diagrams, which have been used over a period of years to discuss domain theory. A much better picture of what actually happens in a ferromagnetic material, as a result of work by Williams and others[1] on magnetic powder patterns, now is apparent. Figure 1*c* is a photograph of a single crystal of iron on which colloidal magnetite powder has been placed. The lines observed are actually domain boundaries, and it is possible, by a technique not to be described here, to know the directions of magnetization in all of these domains. They are shown by the diagram of Figure 1*e*. It will be noted that the directions of magnetization are always parallel to crystal axes. Also, a domain boundary has such a position that the directions of magnetization on the two sides make equal angles with the boundary; this is a condition that must be satisfied in order that no magnetic poles will occur at the boundary.

Figure 1*d* shows the effect of applying a field to the specimen of Figure 1*c*, and Figure 1*f* shows the interpretation. The pattern is the same except that the horizontal zig-zag boundary now is displaced downwards. This 180-degree boundary moves under the influence of the field so that the volume of material, that is magnetized nearly parallel to the applied field, is increased at the expense of that magnetized in other directions. This is experimental confirmation of the "boundary displacement" believed for many years to be the important mechanism of change of magnetization in relatively low fields.

Figure 2 shows a pattern observed on a single crystal surface of different orientation. This is always obtained

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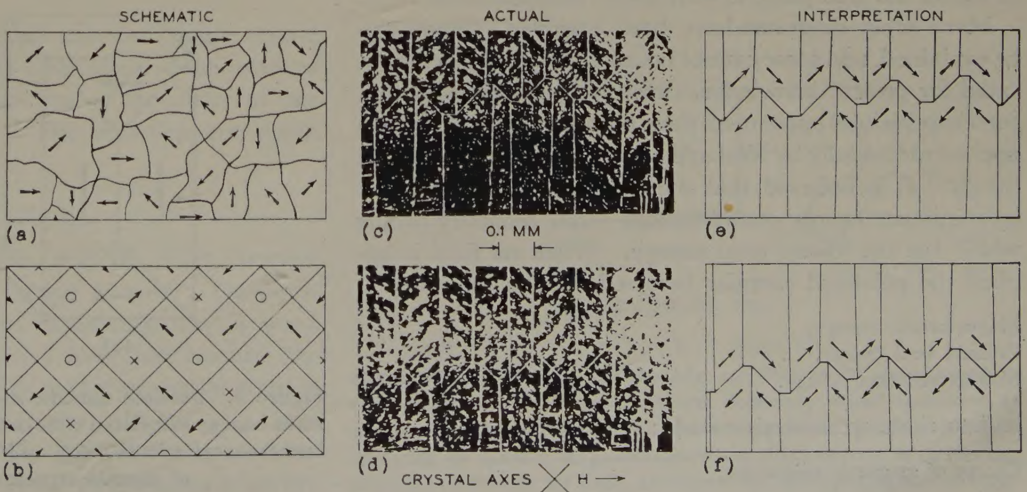


Figure 1. Domain diagrams (a) and (b) and actual photographs (by Williams) of domains (c) and (d) made visible in "powder patterns," in which colloidal particles are deposited on domain boundaries

The directions of magnetization in each domain of (c) and (d) are shown by the drawings of (e) and (f)

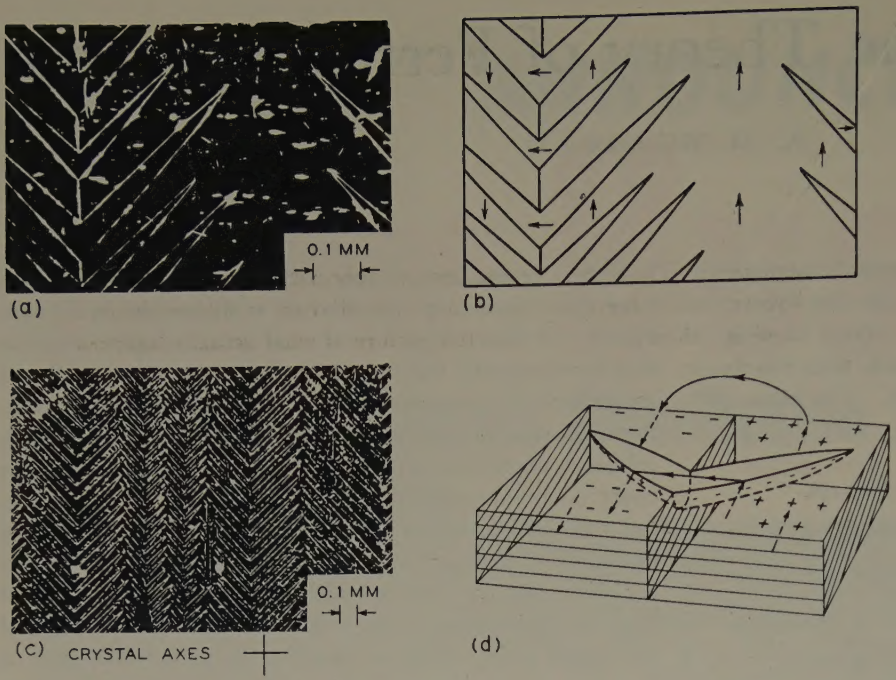


Figure 2. Powder patterns on crystal surfaces of different orientation from those of Figure 1

Part (b) shows the directions of magnetization in the domains of (a), and (d) shows the explanation of this type of "tree" pattern (see text). Part (c) shows a similar pattern under lower magnification

when the surface is inclined slightly to the principal atomic planes of the crystal, 100 planes, and because of its appearance is known as the "tree" pattern. Figure 2*a* shows a photograph with a magnification of about 70, and Figure 2*b* shows the direction of magnetization in each position of the crystal surface. This is a type of diagram which can be explained[1] in terms of domain theory, with the aid of Figure 2*d*. The flux follows a direction of easy magnetization, and where it cuts the surface there are north (positive) poles. If it passes through the air and enters the crystal in an adjacent domain, south (negative) poles are formed. This requires a rather large amount of energy, which can be, and is, reduced by having some of the flux pass transversely through the metal. In this case domain boundaries or "walls" are formed as shown in the figure, and with them there always is associated a certain amount of energy—of the order of one erg per square centimeter in iron. The pattern which actually forms is believed to be a compromise between too much charge and too much wall. This model was subjected to both experimental and theoretical tests, and is believed to have the geometry corresponding to the lowest total energy. Figure 2*c* shows the tree pattern with lower magnification.

Many other diagrams have been observed. Some can be explained, and some cannot because they are too complicated for present knowledge. However, it is known that certain principles apply to all these patterns; they have been applied successfully by Néel and others in developing domain theory. It is believed that the diagrams are determined by minimum energy considerations—that geometry occurs which has the lowest total energy. When no field is applied the principal energies involved are the following:

Magnetostatic energy.
Domain wall energy.
Magnetostriction energy.

and to these we sometimes add:

Energy of magnetic anisotropy.

The first three of these energies are illustrated in Figure 3. Consider a block with edges cut parallel to the crystal axes of easy magnetization. If this is a single domain magnetized upwards, Figure 3*a*, it will have north poles on the top surface and south poles at the bottom. This will mean that flux must go through the air from the top surface to

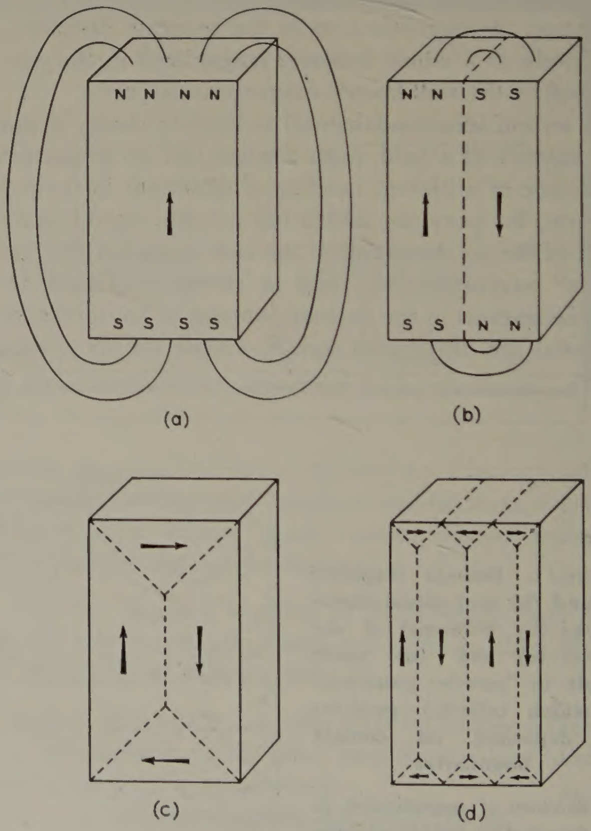


Figure 3. Possible domain structures, showing large magnetostatic energy associated with isolated domain (a), and successively lower energies in (b), (c), and (d); the last represents the kind of domain structure actually observed

the bottom, as shown, and that a considerable amount of energy will therefore be present. This energy is the magnetostatic energy. As an alternative, a domain boundary can be inserted in a vertical plane, as shown in Figure 3*b*. This obviously will decrease the magnetostatic energy but, in this case, there will be some energy connected with the domain boundary itself. This amount of energy is known and is approximately one erg per square centimeter for a crystal-like iron.

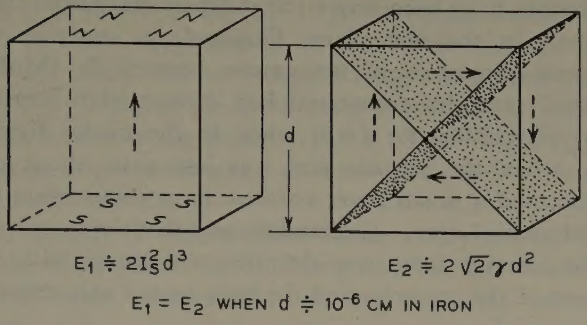

d
$E_1 \doteq 2I_s^2d^3$
$E_2 \doteq 2\sqrt{2}\gamma d^2$
$E_1 = E_2$ WHEN $d \doteq 10^{-6}$ CM IN IRON

Figure 4. Two kinds of domain structure of cubic particle; the first is stable when particle is very small ($d = 10^{-6}$ centimeter), the other when it is large

Another alternative, Figure 3*c*, is to arrange the domains so that there is no magnetostatic energy at all. This involves increasing the energy of domain wall. Also, there is associated with this arrangement a small amount of magnetostrictive energy because there will be some strain associated with the lack of parallelism of the domains—the domains magnetized horizontally will tend to be somewhat longer in this direction, therefore will have to be compressed to fit into the space allotted to them. This magnetostrictive energy is reduced, as in Figure 3*d*, by inserting more domain boundaries. Actual domains are much like these in form.

In some simple cases, it can be shown by calculations that the domain pattern which actually exists is that for which the total of the energies mentioned in the foregoing is a minimum. It is believed that the principle of minimum energy always is applicable, even though it cannot always be worked out in detail.

Usually the domains in a well-annealed single crystal are present as thin slabs, having a thickness of the order of 0.1 millimeter and other dimensions of the order of one millimeter or one centimeter. The domains are much larger than previously supposed.

FINE PARTICLES

The question of fine particles and the high coercive force associated with them is turned to now. The same domain theory can be used in explaining why a small particle may have a high coercive force just because the particle is small. In Figure 4 we have two simple domain structures for a particle of cubic form. In the one, there are no domain boundaries, but there is magnetostatic energy. In the second, there is no magnetostatic energy but a definite wall energy. The energy associated with the first depends on its saturation magnetization I_s, and the length of its edge *d*, and is approximately

$$E_1 = 2I_s^2d^3$$

In the second configuration the energy of the domain boundaries is known to be

$$E_2 = 2\sqrt{2}\gamma d^2$$

In most materials the energy of the second is considerably lower and, therefore, it is the stable one. However, if these two energies are equated, it is found that for iron ($I_s = 1{,}715$, $\gamma = 1.5$) they are about equal when $d = 10^{-6}$ centimeter. Thus the theory indicates that when particles are about this size or smaller, they will be single domains and, therefore, will be magnetized firmly in one direction.

Now, what happens when a field is applied to such a particle? In material of large size it is known that the mechanism of change of magnetization is associated with the displacement of a domain boundary. This was shown in Figure 1 and is illustrated again in the top part of Figure 5. When a field, *H*, is applied as indicated, the domain boundary will move so that there is an increase in the volume of the domains that are magnetized most nearly in the direction of *H*, and a decrease in the domains magnetized in other directions. When this process is complete, the magnetization will begin to turn out of the direction of easy magnetization into the direction of the field. In doing so, it operates against forces associated with the crystal, and acquires an energy which already has been referred to previously as the energy of magnetic anisotropy.

The mechanism of magnetization of a small particle must be quite different. As indicated in the lower part of Figure 5, we start with a single domain magnetized in

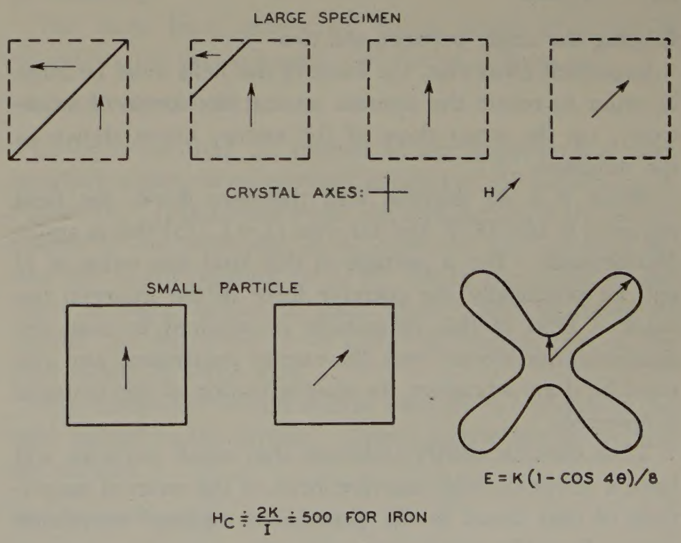

LARGE SPECIMEN
CRYSTAL AXES:
H
SMALL PARTICLE
$E = K(1 - \cos 4\theta)/8$
$H_C \doteq \frac{2K}{I} \doteq 500$ FOR IRON

Figure 5. (top row) Mechanism of change of magnetization (movement of boundary between domains) when specimen is not too small; (bottom row) mechanism when particle is small (rotation of domain magnetization)—in this instance high energy must be overcome by field, as shown by energy diagram at right

one of the directions of easy magnetization. When a field is applied in some other direction, it must act immediately on the forces of anisotropy because there is no boundary to move. The way in which these forces vary with angle is shown in the diagram of Figure 5*g*. The energy of anisotropy depends on the azimuth angle θ as follows:

$$E_K = K(1-\cos 4\theta)/8$$

K is the anisotropy constant, equal to 420,000 ergs per cubic centimeter for iron at room temperature. In order to magnetize the domain at 45 degrees to a direction of easy magnetization, one must supply an energy per unit volume equal to $K/4$. This is supplied by the field, which gives rise to a mutual energy between field and magnetization of

$$E_H = -HI_s \cos \Phi$$

Φ being the angle between the two.

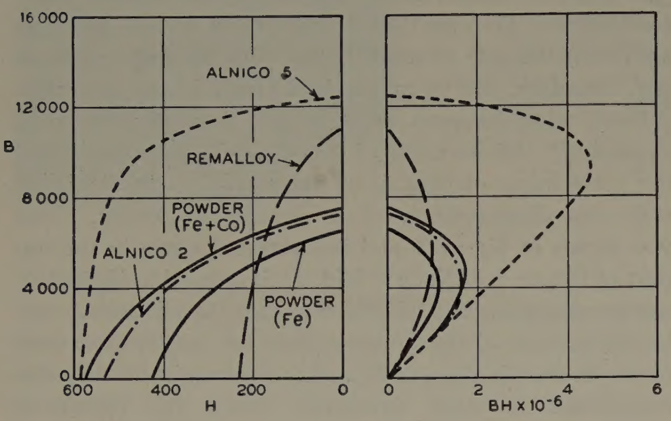


Figure 6. Demagnetization curves (left) and energy product curves (right) of some commercial permanent magnet materials showing properties of magnets of compressed powder

Expressed otherwise, the force of the field must be large in order to rotate the domain against the forces of anisotropy, up the steep slope of the energy curve shown in the diagram.

When θ is 45 degrees, and therefore $\Phi=0$, the field required is $H=2K/I_s$ and for iron ($I_s=1{,}715$) this is about 500 oersteds. For a particle of this kind this value of H will be practically the coercive force of the material because a field of this magnitude is required to take the magnetization vector over the energy maximum, and this must be done whenever the magnetization of the material is reversed.

Thus domain theory indicates that small particles will have a relatively high coercive force, of the order of magnitude of that found in the permanent magnets commonly used. In other words, one can make a good permanent magnet of pure iron if it is prepared in the form of fine particles pressed together so that the density has a value close to that of iron in solid form. Actually such magnets are manufactured now, especially in France, and they compete economically with the more conventional type of permanent magnets which have been known and used for years.

Some curves which reveal their properties, in relation to those of a more familiar type, are given in Figure 6. Somewhat different curves have been reported very recently by Steinitz.[2]

The theoretical considerations leading to the foregoing conclusions have been arrived at independently from three sources. In the first place, Guillaud, in studying the magnetic properties of manganese bismuthide (MnBi), observed that this compound had a very high coercive force ($H_c=12{,}000$ for $I=0$) when in the finely divided form, when the particle size was less than about one micron, and a much lower coercive force (600) when the particles were larger. Guillaud showed that the magnitude of the coercive force was definitely connected with the fineness of the particles and the high crystal anisotropy of the material.

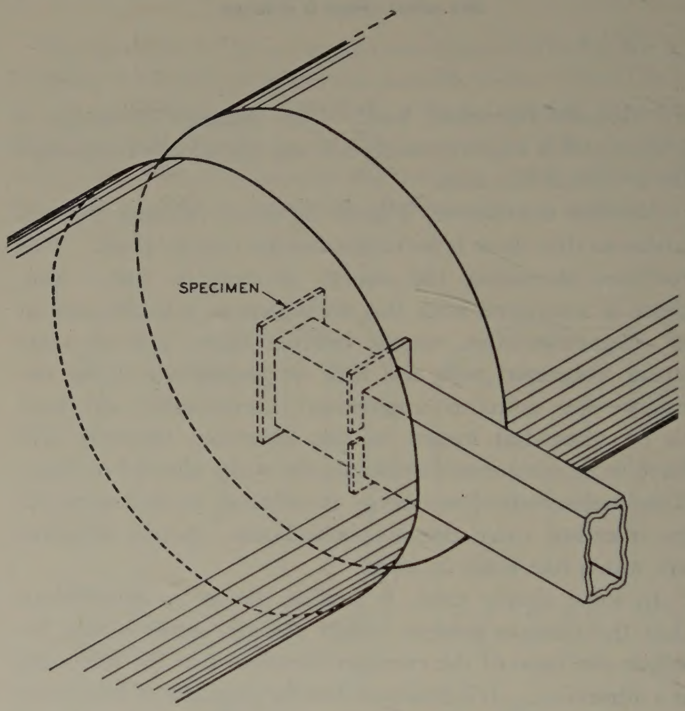


Figure 7. Part of experimental setup for observing ferromagnetic resonance

Wave guide (1/4- by 1/2-inch section) is placed between poles of electromagnet which magnetizes specimen

Further theoretical work by Néel[3,4] applied this idea quantitatively to other materials such as iron. Independently, Kittel[5] showed theoretically that small particles should be single domains, and that the coercive force would be dependent on the crystal anisotropy. Stoner and Wohlfarth,[6] again independently, proposed that small particles of material having high crystal anisotropy energy, or high anisotropy of particle shape or of strain, should have high coercive force of calculable magnitude. They suggested even that some of the permanent magnets of commerce such as the Alnicos might be explained as an agglomerate of very fine particles precipitated in a matrix; this explanation is still open to question.

FERROMAGNETIC RESONANCE

The third matter to be considered is ferromagnetic resonance, an effect uncovered after the war by Griffiths[7] at Oxford, using some of the techniques developed during the war. In brief, the experimental arrangement now used is as shown in Figure 7. A waveguide such as that used in radar equipment is terminated at one end by a resonant cavity, one wave length long, and at one end of this cavity is placed the specimen of ferromagnetic material which may be in the form of a sheet. This sheet is magnetized in an electromagnet, as shown, in a field of several thousand oersteds.

By a study of the resonance of the cavity and its effect on the transmission in the waveguide, one can determine the effective permeability of the magnetic material. Briefly, one measures the voltages in the waveguide at the point at which these are a maximum and a minimum. From this voltage-standing-wave-ratio the effective permeability of the material, μ_R, can be calculated. As the applied field of the electromagnetic is increased, the effective permeability changes, Figure 8, as observed by Yager[8] for nickel, using a frequency of 24,000 megacycles per second (wave length, 1.25 centimeters). It is to be noted that at a certain value of the field, 5,300 oersteds in this instance, the effective permeability passes through a maximum and then approaches the value one. At lower fields the curve goes through a minimum which is much less than one, and at still lower fields again approaches the value one.

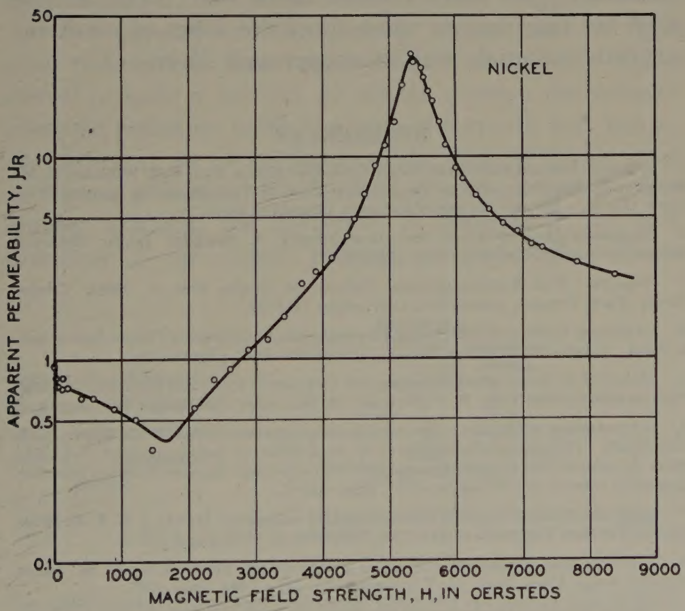


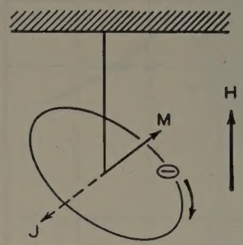
Figure 8. Ferromagnetic resonance curve showing position of maximum when frequency is about 24,000 megacycles per second; on linear scale, peak would seem much sharper

Now, consider the theory as illustrated in Figure 9. This shows an electron travelling in an orbit, the whole being suspended in space—or "hung" by a thread from a fixed support. Associated with this orbital motion is a magnetic moment, M, and a moment of inertia, J, represented by the vectors of the figure.

The numerical relation between the two moments is well known to be

$$M=\frac{ge}{2mc}J=\alpha J$$

in which e and m are the charge and mass of the electron and c the velocity of light. For the orbital motion just described, the Landé splitting factor, g, is one, the usual classical value for the gyromagnetic ratio. If the spin moment of the electron instead of its orbital moment is considered, then $g=2$ must be used, according to atomic theory. Now let a field H be applied in a vertical direction. Then the orbit and its associated M and J will precess around the axis of H with a known frequency. If now a high-frequency alternating field, H_{rf}, is applied at right angles to the axis of H, and its frequency is adjusted to equal the frequency of precession, the system will be unstable and the effects common in resonance circuits will be observed.



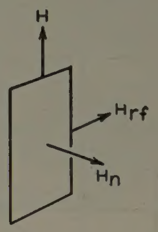


Figure 9 (left). Relation between magnetic moment, M, and mechanical moment, J, of electron in orbit; applied field, H, causes precession around H

Figure 10. (right). Three components of field acting in the specimen

For those that understand things better in terms of equations, the vector equation of motion is given as

$$dJ/dt=M\times H=\alpha J\times H$$

This equation may be applied to our experimental case in which a sheet is magnetized parallel to the surface, as in Figure 10. If this sheet forms the end surface of the cavity excited in the dominant mode, then the applied field, H, and the high-frequency field, H_{rf}, lie in the plane of the sheet at right angles to each other. The equation of motion can be solved if we know the components of the field along all three axes.

The component which is most difficult to evaluate is the field normal to the surface. This is determined by writing the relation

$$B_n=H_n+4\pi M_n=0$$

The net flux perpendicular to the surface, B_n, is zero because no field is applied in this direction, but as the electron precesses its magnetic moment will lie momentarily at an angle to the surface.

Therefore, according to this equation, $H_n=-4\pi M_n$.

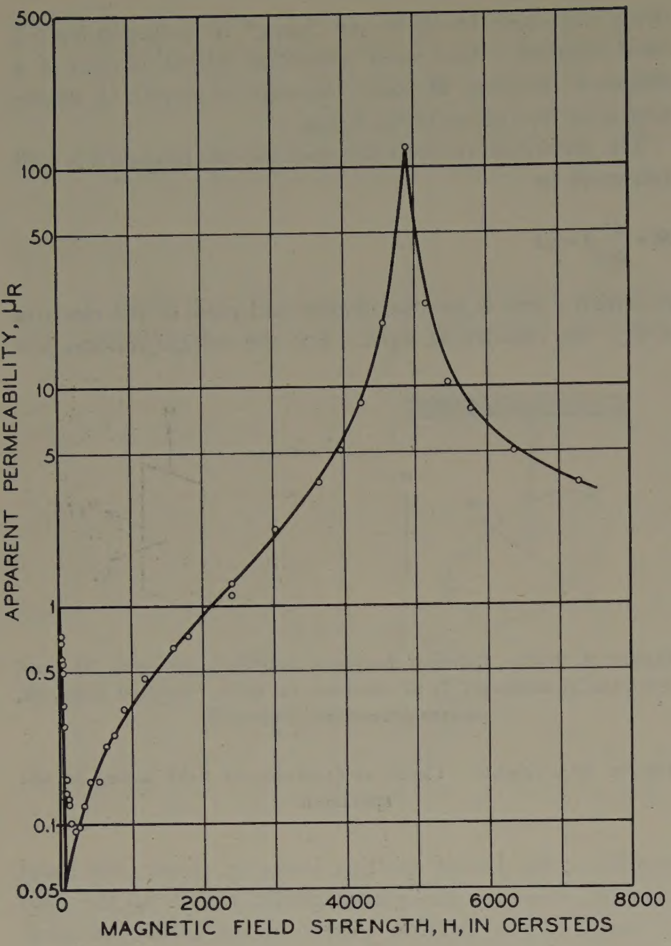


Figure 11. Resonance curve of Supermalloy showing sharp maximum; note low value of apparent permeability at minimum, when μ_R reaches value of 0.09

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This was pointed out by Kittel,[9] who obtained the following solution of the equation

$$\frac{M_{rf}}{H_{rf}}=\frac{M}{H}\cdot\frac{1}{1-\dfrac{\omega^2}{\alpha^2 BH}}$$

According to this the radio-frequency permeability ($\mu_{rf}=1+4\pi M_{rf}/H_{rf}$) is a maximum when the angular frequency is

$$\omega_0=\alpha\sqrt{BH}$$

(At this frequency μ_{rf} is prevented from becoming infinite by the energy dissipated in the material.) Therefore, by determining the maximum of a resonance curve, such as that of Figure 8, one should be able to determine the value of α and, therefore, the value of g. Theoretically, in first approximation it is expected that $g=2$ for ferromagnetic materials because their ferromagnetic properties are known to be caused primarily by electron spin and not by orbital motion. Approximately this value is found but not exactly. For iron the observed value is $g=2.17$. Table I shows the values of g determined from various microwave experiments by Yager,[8,11,12] Hewitt,[10] and others; and also the related value, which may be called g', determined more directly from the gyromagnetic effect as reported by Barnett[13] ($g'=2$/gyromagnetic ratio). The explanation of the discrepancy so far has not been clarified, although some suggestions have been made.[14,15] Unfortunately, at this stage one must leave the situation somewhat up in the air and look forward to its solution.

Table I. Values of g and g′ Determined Respectively From Ferromagnetic Resonance and Gyromagnetic Experiments

Material	Values Derived From: Ferromagnetic Resonance, g	Gyromagnetic, g′
Iron	2.17	1.93
Nickel	2.19	1.91
Supermalloy*	2.17	1.91
Heusler Alloy	2.01	2.00
Ferrite*	2.20	2.04

* Specimens of rather different compositions were used for g and g'.

There is one interesting point in the resonance curve to which attention should be drawn. At the minimum the apparent permeability in Supermalloy, Figure 11, has been observed[12] to be about 0.09, and a value of 0.06 has been measured. Such a surprisingly low value is associated with resonance phenomena when the force and displacement are out of phase. In our case M and H are almost 180 degrees out of phase with each other, and the material behaves somewhat as a strongly diamagnetic substance. The eddy current losses that occur at this point are only two or three times the losses of nonferromagnetic materials such as copper and silver.

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A New Thermal Volt-Ampere Demand Meter

M. E. DOUGLASS W. H. MORONG

VOLT-AMPERE demand measurement has been a subject of discussion and interest for many years, and many different schemes have been proposed for measuring it, or approximations to it. This article discusses the technical principles and performance of a thermal volt-ampere demand meter and does not consider the problems of rate structures and their relation to units of demand measurement.

A study of the general problem of volt-ampere measurement some years ago showed at least 40 patents issued on various methods of measuring or registering kilovolt-amperage. Because all of these methods have either cost, maintenance, or accuracy problems involved in their application they have not been widely used, and the extension of kilovolt-ampere rates by those who want them has been hampered. To meet the needs of those who wish to measure kilovolt-ampere demand, a parallel-circuit voltage-compensating scheme for a thermal ampere meter to give an indication of kilovolt-amperes over a range in voltage has been developed.

An elementary diagram of the electric circuit is shown in Figure 1. As current is drawn by the load, a current proportional to it flows in the secondary circuit of the transformer, *CT*. This secondary current divides between the two parallel circuits inversely proportional to their total resistances. Since the resistance of one side of the circuit is made a function of voltage through the voltage-operated resistance valve, the ratio of currents, and, hence, the difference in energy input to the bimetal spirals (that is, pointer deflection) is a function of voltage. As the line current changes, the difference in currents in the two branches of the circuit changes proportionally. Thus, the difference in energy input to the two spirals is a function of line voltage and line current.

Figure 1. Circuit diagram of thermal kilovolt-ampere demand meter

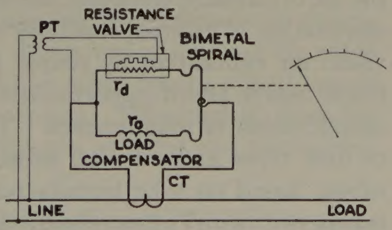


Figure 3 shows the resistance valve and load compensator. The resistance valve is a temperature-sensitive resistor, r_d in Figure 1, thermally coupled with a heating element, the assembly being encased in a glass envelope. The heating element is energized by the potential transformer, *PT;* hence, its temperature, and the temperature of the associated resistor, are a function of voltage. The load-compensating resistor, r_0, is a temperature-sensitive resistor so adjusted that its resistance change as a function of current balances a similar resistance change in r_d.

Figure 2. Bimetal spiral and insulating shield

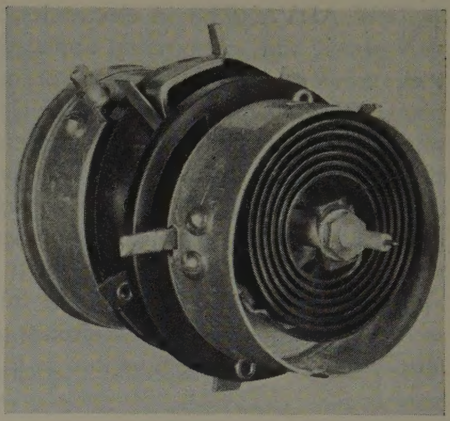
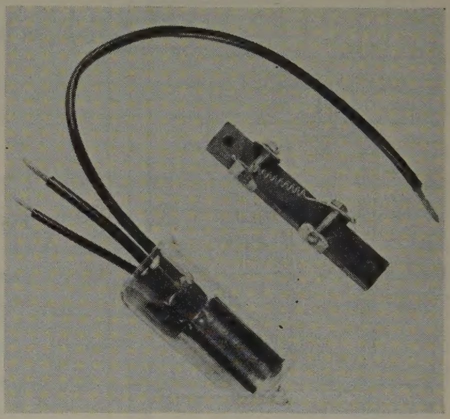


Figure 3. Resistance valve (lower left) and load compensator



To provide satisfactory volt-ampere registration, it is necessary to obtain a sufficient change in resistance ratio of the sides of the parallel circuit, as a function of voltage. This is accomplished by the resistance valve, resulting in a thermal meter giving an indication of volt-amperes over a range of voltage.

Performance tests on samples of the meters indicate that for an ambient temperature range of −20 degrees centigrade (−4 degrees Fahrenheit) to 50 degrees centigrade (122 degrees Fahrenheit) the errors in indication are less than 3 per cent of full scale from 1/4-full-scale load to full-scale load. For a range of voltage of ±10 per cent from the rated value, the meters register within ±2 per cent of full scale from 1/4-full-scale load to full-scale load. Power factor obviously does not influence the registration since the only interaction between voltage and current comes in the thermal coupling of the resistance valve.

Digest of paper **49-22,** "A New Thermal Volt-Ampere Demand Meter," recommended by the AIEE instruments and measurements committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS,* volume 68, 1949.

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Electronic Relay Developments

J. J. LOVING
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NEW ADVANCES in electronics, accelerated by the recent war, offer many applications in addition to their use for military, aviation, or communication purposes. Heretofore, the use of electronic circuits in relaying schemes has been mainly to supplement the more conventional electromagnetic schemes. Examples are the use of carrier current in a pilot directional scheme and auxiliary electronic relays for timing. The purpose of the development work described here has been twofold—firstly, to apply the newer techniques to the fullest advantage and secondly, to employ electronic circuits so that they will perform complete relaying functions in themselves. The advantages offered by these new electronic relay circuits compared with electromagnetic or prior electronic types are

1. The number of moving parts and contacts has been reduced to an absolute minimum by having all functions of fault detection, determination of direction and distance, insertion of intentional time delays, and so on, performed by the electronic elements.

2. The circuits are constructed of standard electronic parts.

3. A high degree of accuracy is obtainable in the determination of overcurrents, the measurement of distances to faults, and in the insertion of intentional time delays.

4. The sensitivity of the vacuum-tube elements provides fast action even with very low control voltages.

5. There are a minimum of magnetic parts, eliminating errors due to saturation.

6. All vacuum-tube circuits place very light loads on the tubes with a minimum of tube types involved.

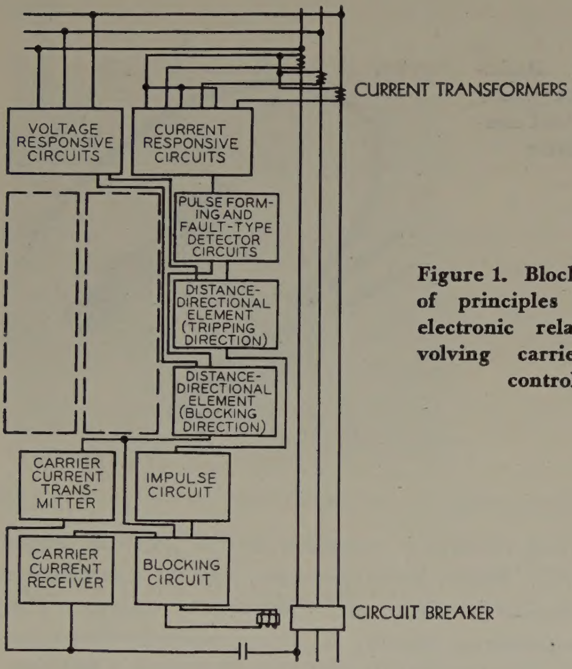
CURRENT TRANSFORMERS
VOLTAGE RESPONSIVE CIRCUITS
CURRENT RESPONSIVE CIRCUITS
PULSE FORMING AND FAULT-TYPE DETECTOR CIRCUITS
DISTANCE-DIRECTIONAL ELEMENT (TRIPPING DIRECTION)
DISTANCE-DIRECTIONAL ELEMENT (BLOCKING DIRECTION)
CARRIER CURRENT TRANSMITTER
IMPULSE CIRCUIT
CARRIER CURRENT RECEIVER
BLOCKING CIRCUIT
CIRCUIT BREAKER

Figure 1. Block diagram of principles used in electronic relaying involving carrier-current control

Electronic relays can be constructed for any type of relaying required, and, in most instances, the relaying for phase faults would fall into one of three classifications: directional overcurrent; distance-directional; and carrier current. The type of ground fault protection would be co-ordinated with the phase fault protection.

Figure 1 is a block diagram illustrating the methods used in an application involving carrier-current control. Since the electronic elements are voltage-actuated, the line currents are not utilized directly, but voltages proportional to line currents are converted to series of sharp voltage pulses by electronic pulse-forming circuits. The phase and polarity of these pulses then are compared with the line voltages for determination of direction, with a balance between voltage and current for determination of distance. If the fault is in the tripping direction, the pulses are allowed to pass to an impulse circuit for actuating the circuit breaker, unless blocked by a received carrier signal. If the fault is in the nontripping direction, the pulses are passed to a circuit for turning on the carrier transmitter and blocking tripping at the far end. Since the action of the transmitter is at very high speed, tripping for internal faults can be accomplished in 1/2 to 1 cycle, since it is unnecessary to turn on the transmitter in case of internal faults.

In Figure 1, a distance-directional element, responsive to faults in the tripping direction, actuates the impulse circuit. This causes circuit-breaker tripping unless prevented by the blocking circuit, controlled by the carrier-current receiver. A second distance-directional element, responsive to faults in the reverse direction, actuates the carrier transmitter.

The results of this development work indicate that electronics can be utilized to obtain improvements in the accuracy, speed, and co-ordination of protective relays. By the use of standard electronic parts in their construction, the elimination of external auxiliary equipment, and the provision for calibration by simple potentiometers, the electronic relays afford opportunities for savings in cost and simplification of maintenance. They require a minimum of tube types and are well suited to using "ruggedized" tubes; based on tube manufacturers' data and operating experience with other electronic equipment in utility applications, an average tube life of three to five years reasonably can be expected. Their versatility makes them adaptable to any relaying scheme by the combination of functions into integrated units or by simple circuit changes to obtain desired characteristics. In the development of the relay circuits, consideration was given to making them as nearly independent as possible of the uncontrollable factors that might be encountered in use, so that optimum performance would be obtained at all times.

Digest of paper 49-66, "Electronic Relay Developments," recommended by the AIEE relay committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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Progress in the Design of Traction Motors

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The past quarter of a century has witnessed important progress in traction-motor design. The primary objective of the designer has been to achieve weight reduction. In order to evaluate the advances made along this line, the author uses "speed-ratio power" as a basis of comparison.

ALTHOUGH the traction motor at some 60 years of age is one of the oldest in the electrical industry, nevertheless it is a thriving oldster with an annual output of approximately 2,500,000 horsepower which has in the past quarter of a century staged a decided comeback on account of the rapid development of the diesel-electric locomotive.

This period has been marked also by the development of the PCC (President's Conference Car) standardized trolley car and the increasingly popular trolley coach, and by the application of 3,000-volt trolley power to commuter service multiple-unit cars and to new types of locomotives both here and abroad.

It is the purpose of this article to review the progress that has been made in traction-motor design, and to note the particular design changes that have contributed to the improvements made.

Design Objectives. Traction motors are designed primarily for minimum weight. This is particularly true for trolley cars and coaches where weight is at a premium and also, to a somewhat lesser degree, for rapid transit. For diesel-electric locomotives where so much vertical space is required by the engine, a small wheel size is also important. On trolley locomotives, additional weight in the motors usually would be permissible, where ballast is used, to obtain required weight on the locomotive drivers. Large heavy motors have been found, however, to add more to the cost of a locomotive than is saved in ballast.

Efficiency plays but a minor role in traction-motor design. Any increase in efficiency, if obtained at a cost of increased weight, tends in general to be offset by the added cost of hauling this extra weight around. Nevertheless, there has been a decided gain in efficiency as speed and horsepower have increased.

Comparing Motors by Speed-Ratio Power. Two factors are of primary importance in measuring the application capacity of a traction motor: continuous rated horsepower, and the ratio of maximum permissible to rated speed. The first factor, rated horsepower, requires no comment since this generally is accepted as the primary if not the only measuring unit. The traction motor however must be rated at a relatively low speed, and it also must be capable of operating at maximum permissible speeds ranging from two to five times its rated speed. If variation in rotation losses with speed could be ignored and if the ratio of mechanical to electrical material could be assumed to be a constant, a motor with a speed ratio of five would have five times the tractive effort and five times the size and weight of an equal horsepower purely hypothetical motor rating only at the maximum permissible speed. The product of these two factors: the ratio of maximum to rated speed, and the rated horsepower is called here "speed-ratio power" and is used to compare, in Figures 1 to 7 inclusive, the advances made over the years in the various lines of motors. Gains range from 70 to 300 per cent depending upon the application.

Speed-ratio power is an accurate measure if used to compare motors that are not too widely apart in peripheral speed at the rating. In each instance, the comparisons are for a given class of service, and the error caused by differences in peripheral speed is estimated to be not over five per cent.

Sources of Advancement. Advances in the design of a motor as old and established as the traction motor are arrived at, generally, in such small steps that it is not until the history over a relatively long period of time is reviewed, as has been done in the comparisons mentioned in the foregoing, that the over-all progress can be appreciated. The

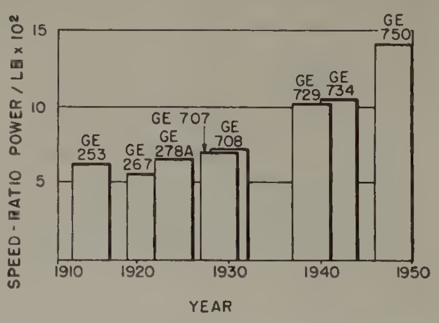

Figure 1. Progress in specific motor output, 3,000-volt locomotive motors

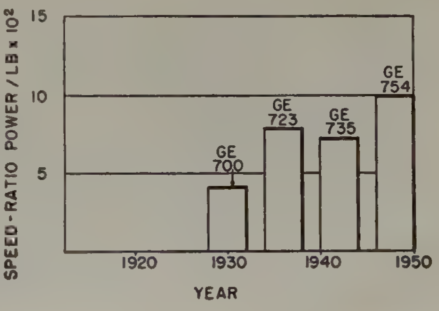

Figure 2. Progress in specific motor output, 3,000-volt multiple-unit car motors

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Full text of paper **49-43**, "Twenty-Five Years Progress in the Design of Traction Motors," recommended by the AIEE land transportation committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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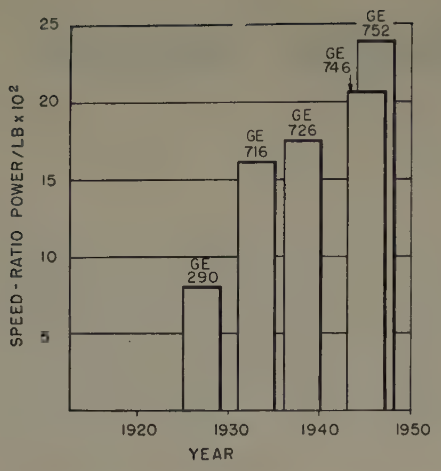


Figure 3. Progress in specific motor output, internal-power road locomotives

advances have been brought about by an accumulation of quite a number of seemingly small changes.

Antifriction Armature Bearings. The first significant change that took place during the past 25 years was the shift from the waste-packed sleeve to the antifriction type of armature bearing. Compared to the sleeve type, any benefit that may have resulted from the reduction in friction on account of the antifriction feature was incidental, although there is no doubt that there was some slight reduction in torque loss on an initial cold start. The antifriction bearing, however, does have three advantages over the sleeve: it operates at high speed with simple and reliable lubrication; it requires less axial space allowing room for increased active material; and the negligible wear with which it operates makes possible better maintenance of gear centers.

The principal problem in connection with the use of antifriction armature bearings has been to keep the lubricant in, and dirt and water out. The solution has been worked out fairly well for grease. Oil is an ideal lubricant for antifriction bearings and very little is required in the bearing at any time. Leakage and vaporization make it difficult to confine and means must be provided continually to replace that which is lost. Where oil is the gear lubricant, it is possible to obtain an adequate supply for the pinion-end bearing from the gear case. In this instance, however, general practice is followed in that the commutator-end bearing is grease-lubricated.

Gearing. On large-size traction motors at the beginning of this 25-year period, twin gearing usually was used. Two gears, pinions, and gear cases were required, one pinion being mounted on each end of the armature shaft, and one gear being mounted on the locomotive axle or wheel hub at each end of the motor. Equalization of gear loading was obtained by the use of springs between the rim and the center of each gear, tangential motion being permitted between the two parts in these spring- or cushion-type gears. About 20 years ago, twin gearing of this type was replaced by single gearing using solid gear, pinion, and gear cover. This change gained added space axially for active material in the motor core and effected an appreciable cost reduction.

Elimination of the second set of gears was made possible in part as a result of the better gear center distance maintenance resulting from the use of antifriction armature bearings, as has been noted, but there also were improvements made in the fundamental design of the gears and pinions. The gearing of the older twin-geared motor was cut and heat-treated, but left relatively soft to permit wear in service to equalize cutting variations in the teeth and the tooth spacing. With the development of equipment for grinding tooth profiles after heat treatment, a harder and stronger gear material was used. The pressure angle of the teeth was increased to obtain more strength in bending. The two small fillets and short tangential section connecting adjacent teeth were changed to a single long radius fillet to minimize stress concentration in the pinion hub and gear rim. The grinding of the profiles improved the division of load on the teeth and minimized the torsional stresses in the armature shaft caused, particularly at high speed, by variation in spacing of the teeth.

Another popular way of obtaining high gear reduction is by making the pinion integral with a short shaft supported by bearings adjacent to the pinion on both sides. This so-called "straddle-mounted" pinion can be made unusually small. Its use has been found practical where the gear unit is separate from the motor, as is the case for truck or body-mounted motors used on PCC cars, trolley coaches, and at least one of the most recent medium-sized traction motors.

Double-Reduction Motors. In the past ten years, the double-reduction traction motor has come into widespread use for internally-powered locomotives operated principally in switching service. Motors of the general type shown at the right in Figure 5 have two reductions; the high speed being of the spur type, and the low speed being a hypoid. All bearings in the case, the pinion-end armature bearing, and also the axle linings are lubricated from the same oil bath. Only the commutator-end bearing of the motor is lubricated separately with grease.

Commutators. Increases in armature speed have been made possible largely as a result of corresponding improvements in commutators. On all high-speed motors, particularly those used in road service, the commutators are spun. This is the word generally used to designate the curing process. It consists of an indeterminate number of cycles of heating while revolving at high speed, cooling, and tightening; this is repeated until a commutator surface is obtained that is smooth and relatively unaffected by variations in either speed or temperature. This process is expensive, but at present appears necessary to obtain commutators which are good for the maximum operating speed of approximately 10,000 feet per minute currently used for most railway motors. Increasing use of commutator spinning has been made since about 1925. The details of the process are continually the subject of developmental work seeking means of obtaining better commutators.

Instead of the usual V-bound commutator, a few of the most recent motors have been equipped with arch-bound commutators. In this type the retaining V-shaped sections of the cap and shell serve only as retractors to draw the bars in toward the center of the commutator and thereby build up tangential or "arch" pressure between the segments. In the so-called V-bound type, the bars are clamped axially between the V-shaped sections without developing high pressure between the bars. Of the two types, the arch-bound commutator generally has a somewhat better surface and requires less spinning.

Brushes. Along with improvements made in commutators there have been complementary improvements made in brushes. Brushes having a porous surface have been developed that are sufficiently nonresilient to follow the minute variation in the surface of commutators. Extensive use has been made during the past eight years of the split-type brush consisting of two parts, each half the thickness of the usual solid brush. Both the change in material and this splitting have resulted in the brushes maintaining more intimate contact with the commutators, particularly at high speed, and have effected a marked improvement in commutation.

Binding and Wedging. Now, the windings of most armatures are held in the core slots by means of wedges, where formerly magnetic steel binding wire was used. When nonmagnetic steel wire was developed, it was used where needed as a means of reducing cross slot flux, thereby improving commutation; and also as a means of reducing band losses, thereby improving rating. With further increases in core speed and corresponding increases in the required amount of binding wire, it became necessary in about 1930 to begin to use slot wedges in the core portion. This change eliminated banding loss in this region entirely and increased heat dissipation from the core teeth. Today, core speeds are approaching 13,000 feet per minute at the maximum permissible vehicle speed in service.

Reroll Banding. In order to bind the end windings down solidly, a relatively new practice termed "reroll banding" has been established on some of the higher speed motors. This operation consists of applying a layer of binding wire, anchoring it at both ends but running one strand over a pulley which is arranged to apply tension in this loop and to take up any slack. The wire is reeled over this pulley as the hot armature is rotated and the high-tension loop travels backward and forward across the winding surface distributing the pressure to all portions of the winding. In the core portion, a steel bar is laid temporarily along the coil in the top of each slot during the binding process. These bars are free to move radially and are of sufficient thickness so that the binding pressure is applied to them and through them to the core portion of the winding. By means of the rest of the turns of wire, the pressure is retained until no additional slack can be taken by the traveling loop.

Truck-Mounted or Body-Mounted Motors. On most of the small railway motors, such as the ones used on PCC cars and trolley coaches, the axle-mounted motor has been abandoned in favor of a motor mounted on the truck frame or body of the vehicle. The connection between the motor and the gear box is of the double universal-joint type quite similar to the ones used on trucks and automobiles. Relatively high gear reductions are made possible in these automotive-type gear boxes. The corresponding increase in speed-ratio power per pound is indicated by comparing the older trolley-car motors with the PCC car motors in Figure 7.

Ventilation. Ventilation has been increased on most traction motors, particularly on the larger sizes which today are blown somewhat harder than was considered economical a few years ago. Early traction motors were made to rely more upon thermal capacity than those designed today. Thirty years ago, motors were series-ventilated, a practice which limited the amount of air to that which could be forced through the armature. Today, practically all traction motors are multiple-ventilated, the air going through the machine in two parallel paths, one through the armature and the other through the air gap and between the stator coils. In the case of motors insulated for 600 volts or less, the air velocity has been increased in the last ten years from about 3,000 feet per minute to its present approximate value of 5,000 feet per minute. On higher voltage and thicker insulated motors it is not worthwhile to blow very hard on account of the unaffected thermal resistance of this dielectric.

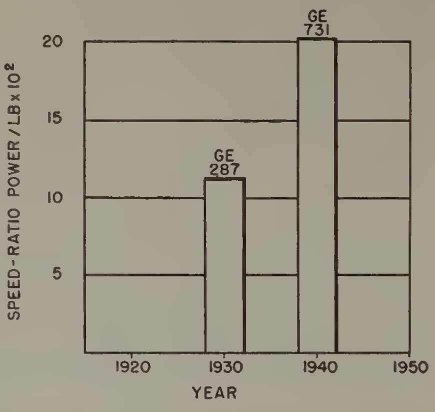
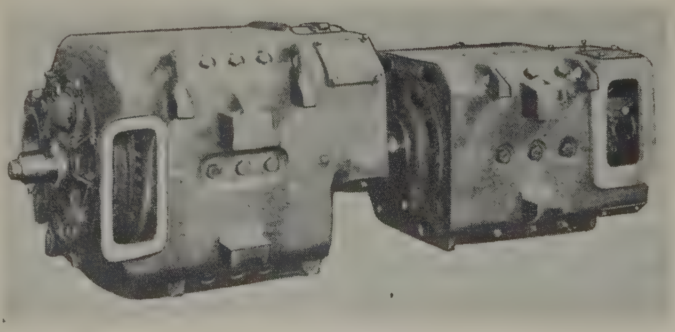


Figure 4. Progress in specific motor output, internal-power heavy switching locomotives



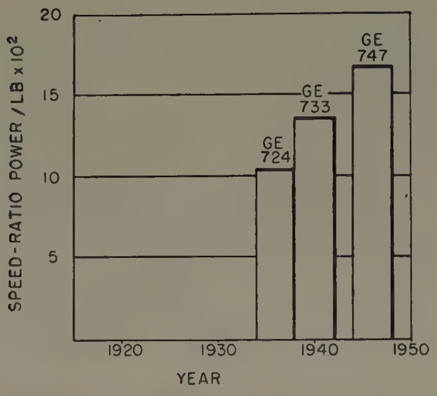
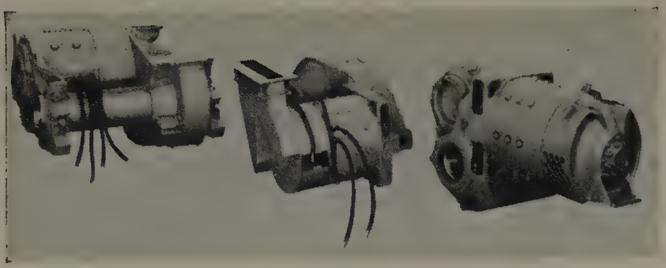


Figure 5. Progress in specific motor output, internal-power light switching locomotives (double-reduction gearing)



Insulation. The size of a given motor is affected to a marked degree by the thickness of the insulation. Thick insulation not only reduces the amount of available space for copper or steel, but also increases the resistance of the thermal path by which heat must escape from the copper. The problem is to obtain an insulation that is consistently good, that may be applied with normal shop handling without becoming damaged, and one that in service will stand class *B* temperatures or higher.

Class *A* materials are not being used on modern traction motors. Mica has been and still is the basic class *B* insulating material. Mica-insulating tapes and sheets have been improved by the use of thinner retaining paper. This newly developed material is but one-half mil in thickness—approximately half the former thickness—but has adequate strength. As this paper is permitted only as a means of applying the mica, the less used, the more heatproof and the more strictly class *B* is the insulation. Increasing use is being made of glass-baked mica tape which completely eliminates class *A* material from the insulation.

Glass outer protective insulation has largely supplanted asbestos. The glass has more per-unit tensile strength making possible a tighter taping or wrapping of coils and, also, a saving in insulation space.

A change was introduced about eight years ago in the method of insulating commutating coils where fields may be connected in the circuit at approximately ground potential, and where the motor is for use on locomotives operating on internal power. The so-called "mummified" type of insulation, in which the coil is completely taped together, has been abandoned as being unnecessarily large and heavy for this particular kind of service. Instead, the first two or three turns, depending upon creepage needed, are taped separately with ground insulation providing full thickness on the end turns and tapering the insulation to provide fewer tapings on the inner turns. Center turns are left bare. The commutating pole is wrapped with insulation, the coil assembled on the pole, the entire unit impregnated in synthetic varnish, clamped on blocks to simulate assembly in machine, and cured in an oven into a practically incompressible, hard unit.

Coils of the type just described are used on small locomotives, where only one connection of motors is required. On larger locomotive motors, where 2-motor combinations make necessary operation of field coils at more than ground potential, a similar coil now is being used and is mounted on a metal spool instead of directly on the pole. Again this is done only for use on locomotives operating from internal power. Permafil, a new synthetic thermo-setting varnish, is used for mica insulation bonding and final impregnation. Center turns on these coils are individually glass-taped. These coils are air-cured, clamped in a mold, and heat-treated into an essentially incompressible, hard unit which differs from the smaller coils in that the commutating pole is removable. The design is indicated in Figure 8. The coils are held in place on the pole by means of multiple-leaf nonmagnetic spring pole tips.

Reduction in Use of Castings. The past quarter century has seen much of the work that once was done in the foundry transferred to the fabricating and welding shop. Only in the largest size magnet frames are castings more generally used than fabrication. Wherever possible, frames have been changed from octagonal to round and formed by rolling at a reduction in cost. Where space limitations require a rectangular or octagonal shape of frame, the cost is marginal and the change to fabrication may or may not prove economical.

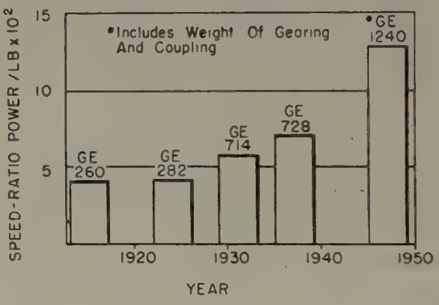


Figure 6. Progress in specific motor output, 600-volt multiple-unit car motors

Fabrication of stators using punched sections welded together have been made on an experimental basis. Figure 9 shows how this type of frame appears after welding and before machining, and also the appearance of the motor completed. These experimental machines have operated successfully in severest subway service for 15 years. This construction offers some advantages, particularly where electrical transients are severe.

Fabrication is used or not used depending largely on a cost basis; both the rolled plate and punched fabrication offer a more uniform flux-carrying medium than castings in which unseen blow holes and porosity are likely to occur.

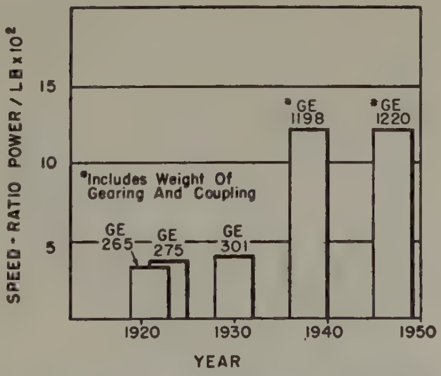
Commutator shells and caps are now generally made from forgings instead of castings wherever the quantity involved is great enough that this construction proves most economical. Frameheads are being "hogged" more and more from ordinary heavy welding plate instead of being made from castings.

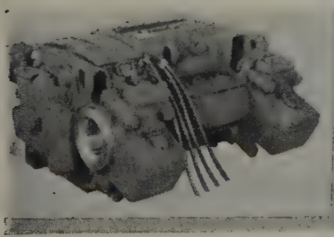
Electrical Design. Although not so apparent, a number of changes in electrical design have been made during the past few years. Many of the more recent motors have made use of the twisted-lead type of armature winding, Figure 10, instead of the solid deep bar; the stranded wire type, Figure 11; or the transposed bar types, Figures 12 and 13. The twist-lead type of armature coil offers high slot-space efficiency combined with low eddy-current loss, both effecting increases in armature capacity. The cost of the twist-lead type is also lower than that of the transposed-bar types. On the motors with three or more coils per slot, the twist-lead type of coil offers a gain in combined space efficiency and low loss as compared to coils of the other types. The more coils per slot, the more the gain on both counts, making this type of coil most useful in higher voltage motors, particularly those for 3,000-volt trolley operation.

While resulting in a reduction in heating and increase in rating, the use of a shallow conductor increases the problem of obtaining a suitable adjustment of compensation to meet the requirements of all coils in a given slot. The eddy currents of the deep conductor tend to equalize the rate of change of current in the several coils during commutation, and also tend to cause some of the energy of commutation to appear in heat rather than sparking. The proper balancing of commutation difficulties against heat reduction is always a problem for any shallow conductor winding when it is used where commutation is inherently difficult.

Windings of the bar type have been used for many years in coils in which the back pitch is not a multiple of the coils per slot. Coils of this type usually are brazed at the end opposite the commutator, necessitating a removable flange and special molded flange insulation; all tending to make this type of coil expensive. There is, however, a definite gain in reduced commutator maintenance when this type of back pitching is used as compared to similar motors where the coil back pitch is a multiple of the coils per slot. In order to take advantage of the twist-lead coil and still use the special back pitching of the bar-type coil, many motors now use a modified form of this twist-lead type of coil which ordinarily is known as the "orphan coil." The design of this type of coil is indicated in Figure 14. Such windings have slot space efficiency comparable to the bar types and are somewhat less expensive in over-all armature cost.

Figure 7. Progress in specific motor output, 600-volt street railway motors





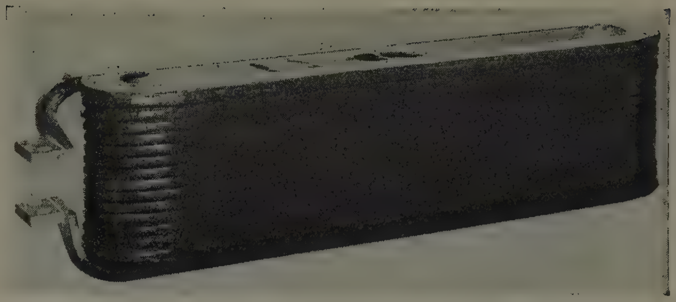


Figure 8. Commutating field coil for motor used on internal-power locomotives

About 1930, it was found advantageous to increase the amount of iron and decrease the amount of copper compared to the ratios used previously. The optimum proportion in so far as the armature is concerned has been found to be about two parts of iron to one part of copper in the effective circumference of the armature. This proportion works out well on motors having more than four poles. On 4-pole motors, it generally has been found advantageous to use a little higher percentage of copper to avoid excessive flux density in the armature core beneath the teeth.

In order to reduce peak voltage between adjacent commutator bars caused by flux distortion, it has been found desirable to increase the air gap from a minimum value at the main pole center to a maximum at the tips. Gaps flared in this way, in addition to reducing flux distortion, also tend to limit losses in the tips on account of the pulsation in flux caused by the passing of the armature teeth.

Standardization. In the last 20 years, much progress has been made in all lines of traction motors toward the adoption of standard machines. The adoption of a standard trolley-car motor as a result of co-operative developmental effort on the part of the car operators put this type of vehicle in competition with the gasoline coach. Similar co-operation between the operators and the manufacturers has resulted in the idea of a standard motor being carried over into the trolley-bus application.

In the field of trolley locomotives, the manufacturers are attempting as much standardization of motors as the several gauges of track and variations in trolley voltage will permit. Designs in this field, however, still are determined largely by the customer through limiting specifications, although every effort is being made by the manufacturers in the United States to adopt standards.

Where complete motors are not standard, certain parts

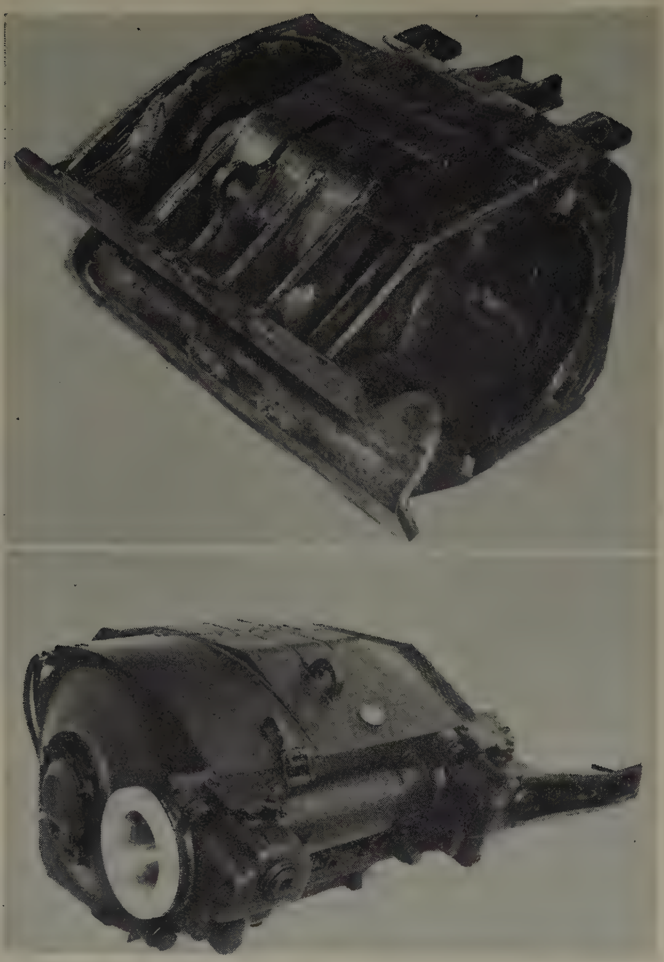


Figure 9. Motor with frame fabricated from punched shapes by welding

are being used as far as possible on different applications.

The internal-power locomotive offers the best possible opportunity for standardization on a widely applicable motor for several different weights of locomotive. The motor shown at the right in Figure 5 is used on 25-, 45-, 50-, 65-, and 80-ton locomotives. Different numbers of motors per locomotive and different gear reductions are used depending on the maximum speed desired, which ranges from 25 to 50 miles per hour. This motor is made to be applicable on any track gauge down to 36 inch minimum.

For road locomotives of 50,000 pounds per axle or over, each manufacturer appears to have adopted a standard motor. Generators are designed to fit the motor since there is less than half the cost in the generator that there is in the motors of a 4-motor locomotive. Not only is there a greater percentage of the equipment cost in motors than in generators, but there is also a larger number of smaller units. Both of these considerations favor motor rather than generator standardization.

It is of interest to note that the motor for internally-powered locomotives is being reduced in size to a point where the wheel diameter, instead of being determined by motor size, is now in some cases on the heavier load locomotives being determined by the weight on the driver—that is, by the per-square-inch pressure on the rail. This situation is new and is welcomed as a possible aid to motor standardization. If the wheel rather than the motor does become limiting, a greater freedom is allowed in the choice of gearing for a small motor or, conversely, the way is opened for a more universal motor not requiring specialized gearing.

Standardization tends to reduce cost and makes faster servicing possible, particularly where the volume is sufficient to make unit exchange possible.

Maintenance and Unit Exchange. The railway motor, like the automobile of today, is more complex, more of a precision tool, and inherently more difficult to maintain than the slower speed motor of 20 or 30 years ago. As in the automobile service shop, the problem of keeping the traction motor service shop fully informed regarding improved factory methods can be solved by specialized training of service personnel supplemented by factory instruction sheets. The improved processes for binding, balancing, and spinning armatures and the improved equipment for handling and testing are being used in the service shop as well as the factory in order to insure uniformly good operation from new and rebuilt equipment.

The increased maintenance problem is not so apparent to

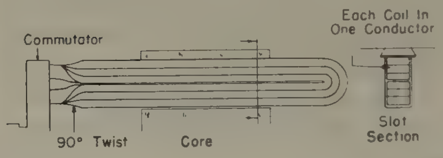


Figure 10. Twisted lead armature coil

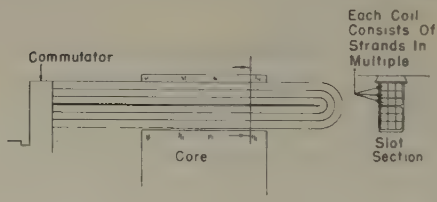


Figure 11. Conventional stranded conductor armature coil

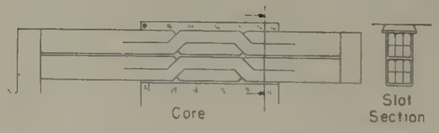


Figure 12. Double crossover bar armature winding

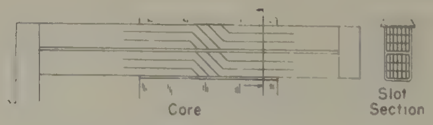


Figure 13. Folded bar armature winding

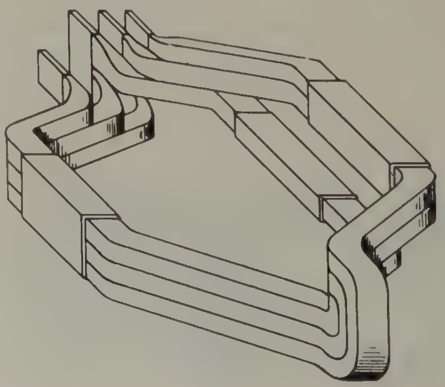


Figure 14. Orphan-type armature coil

the operating railroad which uses standardized motors where unit exchange is available. Under the unit-exchange system, the operator turns in a motor needing service and receives, with essentially no delay, a rebuilt motor in exchange. This method of handling service is one of the most important results of standardization which is not possible with custom-built apparatus. The system of unit exchange spreads the cost of specialized servicing equipment over many users.

Conclusions. The principal way in which power per pound has been increased during the past 25 years has been by means of increases in speed. Considering the limitations imposed by available known materials—cooper, steel, and mica—this increasing of speed has proved to be the only way to accomplish progress in traction-motor design. Much work is being done currently in developing new synthetic insulating materials which may clear the way one day to increased specific output. Higher than class *B* temperatures also are being advocated for railway work. Further speed increases are to be expected despite increasing mechanical problems involved. The curves of output per pound are increasing continually. The interesting problem presented to the engineer is to see that they continue to do so in the future.

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Internship for the Engineering Graduate

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In the medical profession, a period of "internship" during which the young graduate learns to put his knowledge to work has been established as a definite step in the preparation of a doctor for his field. So, too, in the engineering profession is such a period of internship necessary to bridge the transition from theory to practice successfully. This is the third article in a series presented at a symposium on education during the 1949 AIEE Winter Meeting.[1,2]

"IT IS nothing short of criminal to permit a young graduate, with the investment, training, development, and potential he represents, to shift for himself without planned guidance and help, in the hope he will absorb or inhale what he needs to know or acquire about assigned work." With such words did Lawrence Appley,* in speaking to a meeting of the American Society of Mechanical Engineers, describe the importance of a period of adjustment and training for each engineering graduate as he enters industry.

This period of transition from theory to practice is by no means a circumstance peculiar to the engineering profession. I think we can say safely that it is a characteristic of any profession. Law, medicine, the ministry, and teaching all have recognized the importance of this transition period by definitely establishing it, whether toward the close of formal training or following it, as a prerequisite to practice in the profession. Not only does this period provide needed experience, but in most cases it serves as a test as to whether the neophyte can achieve the necessary application of theory to practice. So accepted a part of training for the medical profession has such a period become, for example, that when we use the word "internship," we have a very definite mental picture of the hospital intern in training for his profession. Since we are so familiar with this term in the medical profession, I shall use it to describe the period of training and experience which should follow graduation from engineering school.

ITS IMPORTANCE

Of all the professions, engineering is probably most difficult for the public to differentiate from associated trades. The difficulty may arise from the nature of the materials with which the engineer works. Where other professions are concerned with relations among people and the physical well-being of people, engineering is concerned primarily with materials and products used by people to improve their standards of living. We quite readily accept the idea that other professions must require a period of internship. We hardly could expect a doctor, for example, to learn how to perform a difficult operation by reading a text without some actual operating experience. On the other hand, we often expect an engineering college graduate to solve practical problems immediately without a period of gaining experience and adjusting theory to practice. To this extent industry has regarded him as an accomplished technician rather than as an engineer-in-training.

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* "Opportunity for and Responsibility to the Young Graduate Engineer in Industry," an address by Lawrence A. Appley at the ASME 69th annual meeting, November 29, 1948.

Full text of a conference paper, "Internship for the Engineering Graduate," which was presented at a session on industry's active part in education, held during the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949.

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This mistaken practice has helped to destroy whatever professional consciousness the engineering graduate has developed in college and it delays and often prevents entirely his ever becoming a professional engineer. Colleges, too, are faced with a serious problem in the education of their men. The industrial organization which looks upon the engineering graduate merely as a technician naturally demands of the colleges men who can fill the immediate need, with little interest in the attributes which will determine his success later as a professional engineer. The employer, by contrast, who considers every engineering graduate he employs as a potential chief engineer, who recognizes the distinction between the technician and the professional employee, is equally conscious of the breadth of knowledge such a graduate must have. His only requirement of engineering college graduates therefore is that they have the potential to become engineers. To such an employer a college education is an opportunity for a man to learn how to think, not what to think. In the words of Eldridge Haynes, publisher of *Modern Industry*, "Our educational goal should be to help students to think better than we have thought—to arouse their curiosity for knowledge beyond ours, to nourish a sense of social responsibility greater than we have shown, to inspire higher ethical standards of personal satisfaction than we have had, and to equip them to fashion better tools than we have used, to find the answers to problems we created but have not solved."*

This contrast in the attitude of employers is well illustrated by the statement of a personnel director of a large aircraft company a few years ago. During the early part of the war, in discussing the qualifications which engineering graduates should have, he stated, "Engineers in my organization are always used on the drafting board. That is where the engineering job is done. Of course, we employ a few men with advanced degrees in physics to calculate air-foil characteristics. But what we need in an engineering college is more actual experience on the board." The radical changes in air-foil design and increase in aircraft speeds toward the close of the war made obsolete conventional designs. Men whose design experience had been limited to the drafting board were completely at sea when it came to adapting themselves to the new problems. Sometime later this same industrial representative, recognizing this deficiency in his own company, proposed a curriculum in engineering physics as a solution remarking that the great need was for men who had a broad understanding of the fundamentals of engineering and could apply them to many different problems. He believed that engineering education had failed to develop men with such broad understanding. I am sure that most of those who heard his statement would agree that his proposed course in engineering physics was merely a good basic engineering curriculum and that the real difficulty lay in his assuming that an engineer and a technician are one and the same.

If employers of engineering personnel never forget that the engineering graduate is not yet an engineer but with wise counselling and adequate training and experience he may become an engineer, we shall not only have more truly professional engineers in industry, but we shall have helped also to solve one of the most difficult problems facing engineering colleges: which are more important, specialized courses or fundamental engineering principles.

Thus before we can discuss what a period of internship should give to the engineering graduate, we must be agreed that internship is not only desirable but essential. It is even more necessary than formal college training. Many have risen to prominence in the engineering profession with little or no formal education but no one ever has become an accomplished engineer without experience—without a period of internship. In fact, whether we like it or not and whether we plan it or not, there will be such a period in the career of every engineer. The only freedom of choice then lies in what industry does with the graduate during this time.

THE OBJECTIVE

What is the objective of internship for the engineering graduate and what period does it include?

During this time, the engineering graduate should gain that training and experience which it has not been possible for him to obtain in college and to do so in such a way that at its completion he assumes the full responsibilities of a professional engineer. It is not a very difficult task to provide some kind of industrial experience for the new technical employee. All too few companies, however, realize that the type of experience provided at this point probably will do more to shape the attitudes of the young engineer than any other experience he ever will have.

More important than any other single factor is the relationship between the graduate and the recognized engineer. Associations between master and apprentice, doctor and intern, and artist and novice have evolved naturally as the most effective way by which the necessary training and experience can be gained either for craft or profession. This method of training, while more effective than any other, has become less practical as industry has grown in size and has become more specialized.

The company with a small, well-knit engineering staff therefore has a unique opportunity to develop an intimate, working relationship between its recent college graduates and its established engineers. Even the company with a single good engineer and a sincere interest in developing more can take full advantage of this most effective training method. In other words, there is no substitute for apprenticeship, in the broadest sense of the word, in engineering as well as in mechanical trades.

The larger the company, the more intensive the effort required to make effective this period of internship. From a comparison of the activities of this type organized by various companies, the erroneous conclusion often is drawn that large companies can give, inherently, the engineering graduate superior training and experience.

The time required to achieve full professional status following graduation from college naturally will vary among individuals. However, those men who have studied this problem carefully in most instances have limited the attainment of legal recognition as an engineer to those graduates who have completed from three to five years in the active practice of their profession. For the purpose of this discussion, we shall consider a period of about this length.

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* An address by Eldridge Haynes before the Annual Conference of Society for Advancement of Management, October 30, 1948.

THE PRIMARY EMPHASIS

Of what then should this period between graduation from college and entrance to the profession consist? Much of the basis for my answer to this question naturally is drawn from our experience in the General Electric Company with the recruiting and training of technical graduates. Only as such experience serves to emphasize a particular principle, however, is it pertinent to this question.

Where the primary emphasis in college has been the study of engineering fundamentals, the emphasis in industry must be upon the application of these fundamentals to actual engineering problems.

The heart of this period of internship therefore must be industrial experience. Since the new graduate is unfamiliar with industrial practice, his first job assignment must be of a relatively simple nature. In fact, it should be so simple that he probably will master it in a rather short time. He then should be given additional responsibilities or assigned to an entirely new job. Care must be taken to avoid the extremes of assigning a new man a job so complex he is bewildered completely or so simple that it presents no challenge to him whatever. By shifting him from one job to another at intervals of a few months, he will be successively stimulated in adjusting himself to new responsibilities and environments. A type of assignment often used for such training is the testing of the company's products before shipment to customers. Such assignments are particularly desirable where the product is custom-made rather than mass-produced. The young engineer then will become quickly acquainted with the products the company manufactures and the standards which they must meet. If he has any imagination at all, he also will think of better ways to design and manufacture many of the products which he tests. In companies in which products are manufactured in quantity, a similar type of assignment in the group developing new products will be of like value whereas the routine testing of hundreds of identical units would be worthless from a training standpoint.

During such assignments, the young engineer should have an opportunity to advance from the task of helping a more experienced man in the earlier weeks to complete responsibility for testing products in the latter weeks of his assignment. Such progress will give him a sense of accomplishment and an opportunity for superiors to judge his performance.

The number of training assignments alone is no indication of the value of the training provided. A few, carefully planned to give the young graduate actual work experience and as much responsibility as he can carry, will be much more effective than a number, to which little thought has been given. The new employee can obtain worth-while experience in any company, regardless of its size, where the training of its technical personnel is a first consideration.

AREAS OFTEN NEGLECTED

Actual experience on the job alone, however, seldom will be sufficient to transmute the engineering graduate into a professional engineer. The increasing size of the engineering profession makes more difficult direct contact between the newest engineering graduates and the leaders of the profession. The larger any group becomes the more it is subject to fragmentation and disintegration, and the engineering profession is no exception. The engineering graduate on his first job is particularly conscious of his lack of identity as a member of any group. He has lost the intimate contact with his college class with which he was so long associated and he is not yet established as a professional engineer. To meet this need during the period of internship and to equip the young graduate more adequately for his future responsibilities, industrial experience must be supplemented in four definite ways.

First: The engineering graduate should be introduced, properly and carefully, to his company, his community, and his professional society. Although many employers will feel their responsibility ends with acquainting the new man with the company, the attitude and performance of the engineering graduate is as much or more affected by his community and society experiences. In many instances, the community and the local Section will make independent arrangements to make the newcomer welcome and to include him in their activities. But if the initiative is not taken by others, the employer must recognize the importance to himself of seeing that the new employee is well received in all three areas.

In larger organizations formal courses usually are planned to provide information about the company, its organization, and the opportunities for engineering graduates. Even though formal courses may be impracticable in smaller companies, a definite plan should be provided to meet this need. Asking engineers with a few years of experience to be personally responsible for making one or more new men "feel at home" when they first arrive has been the highly satisfactory answer of one company to this problem.

Second: An opportunity should be provided for the graduate to continue his technical education. So many companies have established training programs to meet this need that it hardly seems necessary to emphasize its importance. The large number of courses indicates of itself the value that industry places upon continuing the technical education of its engineering personnel. In the few years which a man spends in college, he cannot hope to obtain all the technical knowledge which he must have to discharge his engineering responsibilities successfully. Furthermore, if the engineering college has concentrated properly upon the fundamental principles of engineering, he will need technical training in specialized fields which are of particular interest to his company.

Most industries will recognize also that the course method of instruction which is used in most engineering colleges tends to produce "problem solvers" rather than "project solvers." In other words, the separation of technical education into discrete courses tends to prepare college graduates to solve specialized problems in those individual areas but not comprehensive problems involving many areas. Doctor R. E. Doherty has described his own experience in these words: "When I graduated, I had a burning desire to become a good engineer. But although I had passed creditably my work at college, I was still in a haze about much of the scientific and other theory I was supposed to have mastered. I found that I was not alone; most of my associates, who came from colleges throughout the country, were in about the same fix. ...The simple fact is, I had not learned how to analyze a situation in terms of general principles. Rather, I was looking for a formula and there was no formula; a general principle or concept was all that could help me."* Industry must expect therefore to organize some courses designed to integrate the knowledge of the particular fields which the engineering graduate brings with him from college.

The larger organizations here, too, seem to have a definite advantage in the extent to which technical programs can be organized efficiently. This advantage, however, is more imagined than real. Many colleges are well equipped to provide extension courses in almost any specialized field and will welcome the active interest and participation of engineers in industry. The smaller company can include the engineering graduate more easily in technical conferences and discussions of products and operating problems. The important thing is that the company, large or small, recognize a need for the further training of its technical employees and make those arrangements which are most effective and efficient.

Third: Attention should be given to enlarging the areas of understanding. Many technical graduates have a tendency to exaggerate the importance of purely technical ability. This tendency is a natural one for most of these selected engineering as a career because of their interest in mathematical and scientific fields rather than in business or cultural areas. While making use of the high degree of technical ability of the new graduate, industry should encourage him to broaden himself during the early years of his industrial experience. Only with a broad understanding of engineering and its relation to society can he develop professional stature. The forward-looking industry is therefore particularly anxious to provide an educational program in nontechnical fields such as economics, public speaking, and industrial relations. The employment records of many companies indicate that only a very small percentage of college graduates are released for lack of technical ability. In the past few years, engineering colleges have included many nontechnical courses in their undergraduate curricula to help meet this situation. The colleges alone, however, cannot be expected to provide a complete solution. Industry must recognize that potentially it can provide much more realistic experience than educational institutions even in these areas. What it means to co-operate with the draftsman, the shop foreman, and the sales engineer in the design of a product, for example, can be demonstrated by actual case histories. Each company is, in a sense, a laboratory in which the results of applying simple principles of economics or industrial relations can be observed just as effectively as a physical test of a piece of equipment. Whether by instruction in organized courses in these fields or by informal conferences and discussions, no company can afford to neglect the unique opportunity it has to enlarge the areas of understanding of its technical personnel.

Fourth: Adequate guidance and counselling should be available to such employees. Without such guidance no amount of technical training or orientation programs will discharge adequately the responsibility of industry to the engineering graduate. Such guidance is most valuable when it comes from established engineers who have faced similar problems themselves. In a few short years, the engineering achievements of industry will be dependent on the resourcefulness and creative ability of these young men. During the period when they are forming their ideas of industry and their relationships to their company, community, and professional society, we must live as closely as possible to each of them. We must do so not so much to smooth the path ahead as to help them to do a better job than we are doing. Whether in industry or in education we have a great tendency today to establish training programs or courses without ever attempting to measure their real value or to provide adequate guidance to those for whom they are designed. Years ago industrial organizations were small enough that guidance and counselling were provided automatically in the day-to-day relations between established engineers and recent graduates. Too often we have assumed that this relation is sufficient to meet present-day needs of engineering graduates. Actually many employers have so little real contact with their recent engineering graduates, other than on a purely business basis, that they have only the vaguest ideas of their motivating attitudes. A successful guidance and counselling program will be of value not only to the new technical employees individually, but also will help to measure the effectiveness of the period of internship.

OUR RESPONSIBILITY

Planning a period of internship for the engineering graduate is not a task to be taken lightly. The graduate enters this period with a strong ambition to become a great engineer. He is full of hope for the future and confident of his ability to succeed. In almost every case, he has all of the raw material necessary to achieve that success. That so many fail to do so, we can ascribe largely to the planning and guidance which industry often fails to provide or at best, does so meagerly and with half-hearted interest. What industry does with the engineering graduate at this time, therefore, will determine whether the potential he represents will be realized in his development as a professional engineer, or whether, after years of training and investment, he will fail to measure up.

It is upon us, as individual members of the engineering profession, that this responsibility must weigh most heavily. A strong and vigorous profession, increasingly aware of its obligations to the public, is the reward for adequately discharging this responsibility. Further fragmentation and gradual dissolution of the engineering profession well may be the result if we fail to do so.

Will we accept this challenge?

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Polar Vector Indicator

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THE POLAR vector indicator is a device to indicate the magnitude and relative phase angle of two or three voltages as vectors on a cathode-ray tube screen. A reference voltage is chosen and assigned the arbitrary angle of zero degrees. It is shown as a straight horizontal line whose half length, starting at the center of the cathode-ray screen and extending to the right, is proportional to the amplitude of the reference.

The other vectors are shown with their origins at the center of the screen. Originally, it was expected that it would be best to show the other voltages as lines, the length of the lines giving the magnitudes and the angle between each line, and the reference vector giving the relative phase angles.

However, after the device had been tried in experimental form, it often was found desirable to vary the magnitude of the components of the circuit under test, or to change the frequency of the applied voltage, thus plotting the locus of the voltage or current in question. If this is done, it is more desirable to use a dot as the termination of the vector so that the locus can be drawn without the interference of the main vector line itself. This is the system now used.

Although the circuit itself is rather complex, the method of operation is quite simple. When the reference voltage passes through zero degrees, in a positive direction, the reference deflection is zero, and the tube terminals are switched to one of the voltages to be measured. An instantaneous voltage is connected to the vertical deflecting plates of the cathode-ray tube which is proportional to the magnitude of the test voltage at that instant. Simultaneously, a voltage proportional to the magnitude of the test voltage shifted ahead 90 degrees is connected to the horizontal deflecting plates. The switching instant is only 50 microseconds long, and, therefore, the cathode ray moves so fast that only a spot at the termination of the resulting vector is visible. The other instant in the cycle when the reference voltage is passing through zero in a negative direction can be used to show a second test vector, thus depicting a total of three vector voltages.

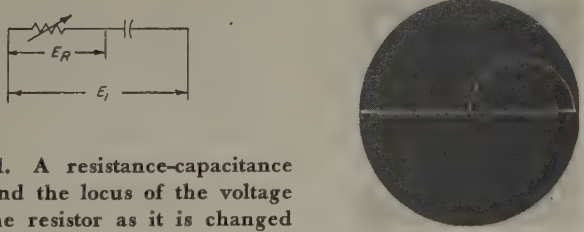

Figure 1. A resistance-capacitance circuit and the locus of the voltage across the resistor as it is changed

The particular model which has been constructed and is here described has a frequency range of from 15 to 300 cycles per second. This is intended to cover the ordinary power range of frequencies. A second model has been designed for use with servomechanisms covering the frequency range from a fraction of a cycle per second up to ten cycles per second. A third model has been proposed for the audio-frequency range. The finished polar vector indicator resembles, in outward appearance, an ordinary cathode-ray oscilloscope. The power supply is mounted in a separate box.

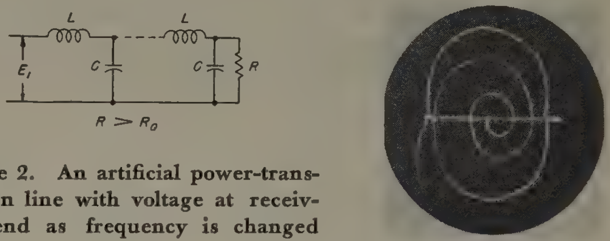

Figure 2. An artificial power-transmission line with voltage at receiving end as frequency is changed

One use for this device is pictured in Figure 1, which shows an ordinary resistance-capacitance circuit with a variable resistance. It is well known that the voltage across the resistance must be 90 degrees out of phase with the voltage across the capacitance. If the voltage across the resistance is measured as the resistance is changed, the voltage vector will describe a semicircle. This is shown by a photograph of the cathode-ray screen.

Another use for this device is shown in Figure 2 where an artificial power-transmission line is measured. In this instance, instead of varying the circuit constants, the frequency of the input voltage was altered. For this test the terminating resistance of the transmission line was made higher than the characteristic impedance of the line. The spiral shows voltage at the termination of the line as the frequency is changed. The result follows the expected relationship where the voltage gradually decreases as the frequency is increased so that the line becomes longer in terms of wave lengths. It is noticed that the spiral is not symmetrical, but is expanded in the vertical direction because of the mismatch between the line and the load.

Similar curves have been recorded for feedback amplifiers to determine whether or not the feedback is sufficient to make the amplifier oscillate. It is easy to show when a corrective network gives sufficient correction to prevent oscillation.

The device also has been used on servomechanism systems to determine whether or not they are stable.

Digest of paper **49-47**, "Polar Vector Indicator," recommended by the AIEE joint subcommittee on electronic instruments and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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Effects of Surface Film on Commutation

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COMMUTATION normally is considered from the standpoint of the reactance voltage produced in the machine due to load current and rotation, which voltage is short-circuited by the brush. This voltage can be considered as being produced by a changing and reversing current through the self and mutual inductance of the armature coils being commutated or it may be thought of as being produced by the armature coils being commutated, cutting a resultant armature field, stationary in space, located in the interpolar space between each main pole and produced by load current in the armature coils themselves. In any case, the designer is interested in proportioning his machine so that the magnetic structure and the winding combinations and commutator and brush rigging give a structure which develops the desired voltage, carries the designed current, and will commutate successfully.

The current resulting from the reactance voltage is limited by the contact drop of the brushes, the resistance of the brush itself, and the resistance of the armature coils. Sparking occurs when certain magnitudes of voltage and current result at the brush, which values depend on several factors effecting the intimacy of contact between the brush and the commutator.

Mechanical bar-to-bar roughness of the commutator and vibration of the machine result in poor contact, which can lead to sparking. The contact drop at the brush varies with the constituents and processing of the brush itself. This is limited ordinarily to a value in the neighborhood of 1/2 to $1^1/_2$ volts. A high value is desirable from the standpoint of limiting the circulating current, but produces excessive heating on account of the load current.

Copper from which commutator bars universally are made is affected by atmospheric conditions, with the resultant film formation on the commutator surface. Oxide films are conducive to successful commutation, while films produced by many gases such as hydrogen sulphide, are detrimental. As little as one part of hydrogen sulphide in 35,000,000 will result in the formation of a tarnish film on copper. Water vapor is also necessary for commutation in air. A value of $1^1/_2$ grains per cubic foot of air is the minimum.

Brushes sometimes pick copper, small flakes of which, sometimes so minute as to be unseen by the naked eye, and up to sizes of 1/16 inch or more square, become embedded in the face of the brush. This occurs most often when hydrogen-sulphide gases are present in the atmosphere. This copper forms copper-to-copper contacts on the commutator and results in threading of the commutator and poor commutation.

Contaminated gases from industry, such as from chemical plants, coke ovens, and so on, can contaminate the air in which d-c machines operate, to the extent of causing poor commutation and excessive wear of the commutator and brushes. In such instances, the installation of a recirculating ventilating system with water-to-air coolers, mechanical filters for removing dirt and carbon dust, and activated charcoal filters, will provide clean and cool ventilating air for a d-c machine.

D-c machines can be operated in a hydrogen atmosphere with successful commutation and with no changes in the electrical design. If, however, sparking is present, the brush wear may be higher than in air, unless the relative humidity is kept below ten per cent.

Vapors from silicone insulation on totally enclosed recirculating ventilating systems on d-c machines, can result in destructive sparking and rapid brush wear. The concentrations required for this are very minute, being in the neighborhood of 10 to 200 parts per million. Temperature of operation of the machine affects this, as rate of vapor elimination increases with the temperature, even after the varnishes have been cured by high-temperature bakes.

Oftentimes, obnoxious commutator surface films are removed as formed, by the use of cleaning or scouring brushes. The control of this is very difficult, as the formation of film on a commutator is not constant but varies with the load on the machine and the type of brush used. The solution is simply a cut-and-try proposition, and may require the addition or removal of cleaner brushes with time and load variations.

Since commutator surface-film conditions exert a large influence on the successful commutation of d-c machines, duplicate machines, even though they pass the manufacturer's tests successfully, may operate with an entirely different performance in the field. While loading conditions have a pronounced effect, this variation is often due to the surrounding atmospheres under which the machines have to operate.

At the present time, very little is known about the intrinsic properties of the surface films produced on commutators under various operating conditions, but the detrimental effects are recognized. Much work is being done on producing brushes inherently designed or chemically treated during production to react with the films. Where satisfactory brushes cannot be obtained for a given installation, the use of scouring brushes, occasional grindings of the commutator, or the installation of a controlled ventilating system are necessary for successful continuous operation. Continued work on this will lead to modifications in the design of the machines or developments in the chemistry or processing of brushes which will provide satisfactory operation under adverse atmospheric conditions.

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Solid Short Circuit of D-C Machines

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THEORETICAL work on the determination of short-circuit current in d-c machines is now sufficiently complete so that standard practices can be set up in the same way as already has been done for synchronous machines.

Similarity between the formulas for d-c and synchronous machines is noted. For a d-c machine, the current on short circuit, i_a, is

$$i_a=\frac{e_0}{r_d}-\frac{e_0}{r_d'}\epsilon^{-\sigma_a t}+e_0\frac{r_d-r_d'}{r_d r_d'}\epsilon^{-\sigma_f t} \tag{1}$$

where e_0 is the electromotive force existing in the machine just previous to short circuit (terminal voltage plus or minus winding and brush drop), r_d is the steady-state effective resistance of the machine, and r_d' is the transient-state effective resistance. These quantities are all per unit. σ_a is the armature-circuit decrement factor for the machine, and σ_f is the field-circuit decrement factor. The field current is

$$i_f=\frac{e_0}{n_0}\left\{1+\frac{r_x'}{r_d' n_f}(\epsilon^{-\sigma_f t}-\epsilon^{-\sigma_a t})\right\} \tag{2}$$

where r_x' is the per-unit transient-state compounding resistance (accounting for the effect of armature current on generated electromotive force) and n_f is the leakage-flux coefficient for the field winding.

When a d-c motor or generator is short-circuited, the maximum current is determined by the original voltage of the machine divided by the sum of four elements of resistance. These four elements are: (1) the total resistance of the line windings of the machine; (2) the external line resistance including the effective resistance of the fault; (3) the resistance of the brush contact which is several times normal because, in the absence of an interpole field to counteract the reactance voltage of commutation, an equivalent voltage must be generated at the brush contact (the rise of interpole field strength is delayed by damping of the solid steel parts); (4) the equivalent resistance representing the demagnetization of the machine by the strong armature reaction.

Analysis of these elements of resistance shows that the element representing the demagnetizing effect of armature reaction is a nonlinear function of line current. This is primarily attributable to the demagnetizing action caused by magnetic saturation resulting from the strong cross magnetization.

When the sum of the four elements of resistance is expressed as a function of the current there is no particular difficulty in making calculations for a single machine. But when several machines are connected together in a network the calculation becomes very difficult.

Therefore, the four elements of resistance are derived as constants depending on fixed dimensions of the machine independent of the current. This is done for the element equivalent to the demagnetizing action of armature reaction by determining the action as a function of line current and then approximating the curved function by a straight line. The error involved is found to be small.

The four elements of resistance are added together to give a coefficient, r_d', called the effective transient resistance of the machine. Hence, the maximum short-circuit current is e_0/r_d', where e_0 is the electromotive force of the machine before short circuit.

The elements of resistance are determined similarly and added for the conditions of sustained short circuit (assuming the machine does not flash over). Hence, the sustained short-circuit current becomes e_0/r_d, where r_d is the effective steady-state resistance of the machine.

The rise of current when the machine is short-circuited is $(e_0/r_d')(1 - \epsilon^{-\sigma_a t})$ where σ_a is the decrement factor for the line circuit. The decay of current is $-(e_0/r_d'-e_0/r_d)(1-\epsilon^{--\sigma_f t})$ where σ_f is the decrement factor for the field circuit. The decrement factors are so dissimilar that the components may be added together directly to give the current as a function of time. The result is similar to the well-known formulas for synchronous machines.

The outstanding advantage of the method is that any number of d-c machines may be included in a network, with or without connection of batteries, rectifiers, or other machinery, and calculations may be made using a network analyzer, d-c calculating board, or numerical calculation. The current in any machine, the total fault current, and so on, can be determined.

The words "solid short circuit" indicate the absence of arcing. Although short circuits generally involve arcing, the impedance of the fault in such a case is uncertain. When there is no arcing the impedance of the fault can be determined and will be a minimum. In other words, "solid short circuit" is the worst case.

Characteristically, for d-c machines the maximum current differs greatly from machine to machine. Each one of the four elements of resistance is an important cause for this difference. Calculations and tests show that the maximum current may differ from several times normal current in some machines to as much as 18 times normal current in other machines. The rate of rise of current is very high. For example, values of maximum current are reached characteristically in from one-half cycle to one cycle using a 60-cycle wave as the measure of time.

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The Brain as a Computing Machine

WARREN S. McCULLOCH

The author, a medical doctor, employs electrical engineering terminology to show how the brain may be likened to a digital computing machine consisting of ten billion relays called neurons. To carry the analogy further, the performance of the brain is governed by inverse feedback, subsidiary networks secure invariants, or ideas, predictive filters enable us to move toward the place where the object will be when we get there, and complicated servomechanisms enable us to act with facility and precision. Disorders of function are explained in terms of damage to the structure, improper voltage of the relays, and parasitic oscillations.

ELECTRICAL engineers distinguish between problems of strong currents—or power engineering—and of weak currents or communication engineering. Computing machines, including brains, belong to the latter specialty. Man's brain is much the most complicated of computing machines and it requires power to keep its relays in the operating range of voltage. It is battery-operated, each relay having its own battery. These are charged by a series of chemical reactions beginning with sugar and oxygen and ending with carbon dioxide and water. When these materials are lacking or any step in the chemical reaction is blocked, the circuit action goes completely wrong. Depression, mania, delirium, stupor, and coma are called "functional psychoses" because they disappear when the proper voltage is reestablished. To break up some of these conditions, the brain is stimulated electrically and an epileptic fit produced. This action discharges the batteries so frequently that it exhausts them temporarily, because in a fit the brain uses from 8 to 80 times as much energy as it normally requires. After the fit, it takes some time to replenish the batteries and get ready to go again. We know that it is not those chemical reactions which create the voltage but the voltage itself that matters, for a nerve without oxygen, and so without voltage, can be recharged from a common dry cell; and when the nerve is up to voltage it transmits signals normally. The brain heats the pint of blood that flows through it every minute, one degree Fahrenheit. That is a quarter of a kilogram calory per minute which, in electrical units, is only 2.4 watts. To get rid of it as heat is all that brains can do with spent power. So long as that power is supplied, whether we are communication engineers or psychiatrists, we may forget it.

Instead of power, let us think in terms of information conveyed by signals. These signals can be divided into two kinds. First of these is the analogical signal in which the quantity of some variable changes continuously with that which it conveys, like distance in a slide rule or current in a telephonic repeater. These require precision of workmanship proportional to precision of performance, scarcely can reach the sixth decimal point even in a beam-balance, and cannot be combined to get the next decimal place. The second type comprises the logical, or digital, signals which are divided into a few possible quantities whose number in separate places or times is the message to be conveyed—like pins in a cribbage board or dots and dashes in a telegraphic relay. Such devices require only about ten per cent precision. Their signals are sharpened again at each relay. They can be combined to secure any number of decimal places at no extra cost per place.

The brain is a logical machine. Each of some ten billion relays has only two states: pulse or no pulse. Each relay is a living cell, shaped something like a vegetable with leaves like a carrot, body like a turnip, and a long thin tap root like alfalfa. The cells vary in size; the biggest have a bulb, say two-thousandths of an inch in diameter, fronds a tenth of an inch long, and a tap root a ten-thousandth of an inch in diameter and six feet long. Each of these cells keeps its outside less than a tenth of a volt positive to its inside until it is excited. It can be excited anywhere by driving its outside locally negative. When this happens, current from nearby positive parts of the cell flows into the negative region partly recharging it. but extending the negativity to the region whence the current came so that it, in turn, becomes a sink for current from still farther parts of the cell's outer surface. Thus the pulse of current, shaped like a smoke ring, is propagated along the threadlike cell. The membrane surrounding this cell is a leaky capacitor, its voltage supported by the local battery. The rate at which the pulse travels is determined by the distributed resistance, distributed capacity, and distributed source of voltage of the cell, so that cells can be thought of as distributed repeaters. The fastest, or fattest, conduct at about 150 yards a second; the slowest, or thinnest, a foot a second. As the fast conductors generally connect distant places, and the slow ones near places, the temporal effects of distance are minimized. The pulse itself has a rising phase of approximately a tenth of a millisecond, and it takes several tenths of a millisecond for the cell to be ready to transmit another pulse. It cannot do this often in quick succession without fatigue, however between the time when pulses are delivered to a relay to excite it and the time its pulse starts, there is a delay of about half a millisecond. To excite one cell, pulses from several cells usually must arrive close

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together within one- or two-tenths of a millisecond, and a signal to stop a nerve cell from responding to pulses otherwise sufficient to trip it must precede them by about half a millisecond. Nerve cells sometimes conduct trains 200 pulses per second but usually average nearer 20 per second, so that the duty cycle is from 1/10 to 1/100 of their greatest possibilities.

In a comparison of nerve cells and ordinary relays, the nerve cells are faster than electromagnetic devices, about as fast as thyratrons, about one thousandth as fast as vacuum tubes. However, they are so much smaller that, though their voltage-gradients are about the same in cathode to grid to plate, they take far less energy to operate. A large building could not house a vacuum tube computer with as many relays as a man has in his head, and it would take Niagara Falls to supply the power and Niagara River to cool it. Eniac, with some 10,000 tubes has no more relays than a flat worm. Moreover, nerve cells are cheap. If it cost a million dollars to beget a man, a nerve cell would not cost a mil, and until cathode, grid, and plate can be printed on plastic with only monomolecular films between them, engineers cannot hope to compete with nature. Even then multiple grids would have to be worked out for gating the signals, because on big nerve cells what determines signal or no signal is special combinations from among as many as a thousand terminations of branches of tap roots of various nerve cells on the body of a single cell. At the present moment the most exciting parallel is in the configuration of electrodes on transistors. Computing machine designers would be glad to exchange their best relays for nerve cells. One reason for that is their long life since man gets no replacements from the day he is born until the day he dies. Every nerve cell in a man's head is as old as he is, and most of them are still alive and working. Mechanically, they are more stable than other relays—and each keeps repairing itself. Of course, poisons, germs, failure of sugar or oxygen, failure of blood supply, or a bullet through the head may kill enough to make us run amok. These troubles are called "organic psychoses," because this damage is found in the brain at death.

A CALCULUS FOR NERVE CELLS

The logician, Boole, who first attempted a logical machine, was responsible for a calculus in which the only values of the variables are 0 and 1 and which is applicable to the pulses of nerve cells. Shannon was the first to apply such a calculus to nets of relays; but, because he was interested in circuits either open or closed, instead of in transients opening and closing circuits, he emphasized the logic of their simultaneous or enduring states rather than the dependence of one signal upon those that tripped its relay. Consequently, time is not made a significant variable and so his is rather the logical relations "both A and B," "A and/or B," and "A but not B" than the sequential relation of implication "A at time t only if B at time $t-1$," wherein the unit of time is synaptic delay, or closing time. Walter Pitts and the author took this factor into consideration and made a complete calculus for these signals by taking the calculus of propositions of Whitehead and Russell from the "Principia Mathematica" and subscripting the symbol for the signal of a given relay by the time of that signal, measured in synaptic delays from any arbitrary beginning. This calculus is simple, much simpler than ordinary arithmetic, and it is enormously powerful. By it we proved that a nervous system—even without regeneration—could compute any logical consequence of its input or, in Turing's phrase, compute any computable number. This is the substance of our "Theorem II," which von Neumann uses in teaching the theory of all digital machines. The theory is ready and waiting to be used, and there is only one limitation. You have but half the calculus if you have only relays that never fire unless they are tripped; that is, you have signals which imply A and/or B fired; both A and B fired; A and not B fired; but none which implies neither A nor B fired. In the eyes of the common scallop there are relays which keep on firing unless light falls on the eyes. In man there are no such relays, but he always has a background of nervous activity which serves the same function. Consequently we have for him the whole calculus of atomic propositions. However, perhaps this calculus does something even more important, for it separates physics, for which the signals are only something that happens or else does not happen, from communication engineering, for which these same signals are also either true or else false. If you press on your eye you will see a light when there is no light. The signal is just as physical as ever, but because it arose in the wrong way or in the wrong place, it is a false signal, just as false as a ring on the telephone when lightning strikes the wires. It is because communication engineering deals with signals, true or else false, that neurophysiology is part of engineering, not merely of physics. To understand logical calculi, it pays to learn symbolic logic. With it you can write out at once the specifications for any number of nets to do anything.

Notice its application to sensation. Consider chains of relays from the sense organs to the relay racks in the brain. A signal in the relay rack implies one nearer the sense organ and it in turn, backward in time until we get to the sense organ, and so to the outside world. Thus, what happens in our heads logically, materially implies the world impingent on our sense organs. This material implication is not a symmetrical relation. It extends into the past, not into the future. What happens in our heads does not imply what is to happen in our arms and legs. We send down volleys of signals, but these play on the complicated servomechanisms which keep us right side up and adjusted to the world about us. These have their own input from the world, so what happens is in large part determined by them. We intend, they act. Because what we intend and what we do are not always the same, we are forced to distinguish between what we will and what we shall do. Hence, the notion of the "will." Any computing machine which can detect a discrepancy between what it calculated and its actual output may be said to have a will of its own. The newer machines probably will be able to sense errors and erase mistakes in the output as they must in their memories. Consequently they may prefer magnetic tapes to punch cards.

THE MEMORY

To compute as we do a machine must have some kind of memory. Kubie was the first to propose and Lorente de No was the first to prove that brains have reverberating chains of nerve cells. These are just regenerative circuits in which a set of signals patterned after some input can go round and round. The set preserves the figure of the input but no longer refers to one particular past time. It says that there was some event of that figure. It introduces into our logical calculus the existential operator and the predicated figure, or idea, simultaneously; that is, "there was some event such that it was of this figure." Existential operators combined with negation yield universal operators, and the figures, predicables or ideas, are called universals. Any kind of memory will serve to free universals of the particularity of their origin in time. A victrola record of "Yankee Doodle" does not tell you when it was recorded. But every other form of memory is only a surrogate for reverberating chains. You may use an acoustic tank, a latticed grill within an iconoscope, a wire tape, or punch cards—but the computers must be able to put in and take out information, and so complete the loop round which the information goes. It could be done with flip-flops or with chains of thyratrons, only it would cost too much in space and energy. Nerve cells are cheap, small, plentiful, take little energy, and are not too fast. Our brains have many of these closed chains, enough so that they can run for eight hours on end without much loss of information from this first kind of memory. This becomes important as we grow old. Until then use leaves a trace whereby the oft repeated and successful act becomes preferred and this is also a second kind of memory—also, until then, things seen once leave pictures that fade little, if at all, as years go by. This third kind of memory in several ways resembles a series of snapshots of the world, filed in the order taken and punched for recall at a set of points, each corresponding to one of a pair of opposites, whereby we sort out things that seem familiar to us. We may use these punches for recall, or we may ripple through the stack of shots in the order they were taken and filed. But, as with photographs that have to be developed, this memory is not available immediately after it is shot, but must go through the processes of recall and recognition. From the work of Stroud it is clear that this memory may contain shots taken as often as ten per second. From this it is not unreasonable to guess we have, by the time we die, a series of some 10^{10} shots stored in our heads. Now, if every shot had 33 places where it might be punched for one of a pair of opposites, we would be able to find any one of 2^{33}, which is 10^{10}, shots as is done in a calculating machine. This would account for our ability to recall items on a basis of similarity or dissimilarity, but one would have to be lucky to pick the right 33 pairs of opposites. We probably use far more pairs, perhaps hundreds of them.

No one yet has measured the number of items which a man can store per shot, but it is probably less than a thousand spots, each a jot (a mark), or else a tittle (no mark). So let us allow for code to find a shot and contents of each shot, a total of 10^{10} shots which is a total memory of 10^{13} spots. This is more items of information than there are connections of relay to relay. One might "solder in" the multiplication table, or his skilled acts generally, but not this snapshot memory. It begins to look as if these shots were filed in that small, deep portion of the brain which is spoiled regularly by too much alcohol, producing what is called Korsakow's psychosis. There we may look to something about as big as a molecule of protein for each spot of memory.

In this respect, Heinz von Foerster ("Das Gedachtnis," Vienna, Austria, 1948), by applying modes of reasoning and the data of theoretical physics to the best psychological data on the learning of nonsense syllables, evolved hypotheses which indicate that:

1. The traces left by experience are probably quantized alterations of protein molecules, some 10^{21} in number.
2. The total power required for the maintenance of this memory is of the order of 10^{-2} watt.
3. The energy per step is in the near infrared, say 28,000 angstrom units, which is in the range of enzymic resonance.

His theory requires that traces to survive must be reconstituted in new carriers and only protein molecules are known to have the property of producing facsimiles of themselves. This theory fits with the known facts of protein denaturants destroying memory.

We have, of course, a substitute for memory, inasmuch as we can make any sort of mark and, at some future time, sense it again. But this, like all the rest, is but a substitute for reverberating chains. We must close the loop when we make use of it.

NEGATIVE FEEDBACKS IN THE NERVOUS SYSTEM

There are other closed paths within the central nervous system, through it and the body, and through both and the world which are negative feedbacks. Each of these serves to establish some state of the system. They respond to every deviation from the established state by returning the system toward that state, and this state is thus the goal, aim, or end of that operation. Those that go through the world about us are called appetitive, for by them, like the self-guided torpedo or the gun with automatic fire control, we hunt our prey. Those that go through the body and brain are called reflexes and they serve to give dynamic stability to our temperature, blood pressure, circulation, water balance, blood sugar, blood carbon dioxide, and so forth, as well as to our posture and motion at rest and under many conditions of acceleration, including gravity.

At the time that the first joint paper was written by Pitts and the author, we could secure only existential operators to free ideas of temporal particularity, using regenerative feedback. Then it became clear that every reflex, or negative feedback, might be so used. For example, the pupillary reflex tends to keep constant the excitation of retinal receptors by adjusting the diameter of the pupil oppositely to the brightness of the field of vision. Thus, it tends to free retinal excitation of the gratuitous particularity of the amount of illumination. The number of signals relayed through lower parts of the brain to the cortex, or bark of the brain, has another inverse feedback which also acts as an automatic volume control; for, as more impulses reach the cortex, it decreases the number relayed thither. These enable us to see the same thing regardless of the brightness. The existential operator is now, "there was some brightness such that it was this or that thing."

Another reflex is even more important here. The points of the retina are mapped, one for one, on the back of the midbrain, and the cells there are so connected as to compute a vector from the central line of gaze to the apparent center of gravity of anything in the visual field. They then relay this vector to the cells that control the eyes which then move them so as to reduce the vector. That is, they turn the eyes so as to center the apparition. This reduces the vector to zero and the eyes come to rest with the form centered. By moving the apparition to the center of the field, this reflex rids the apparition of the gratuitous particularity of the position in which it first was detected. Thus, "there was some place such that it was this or that apparition." In a similar manner every reflex takes some input through a series of values of some variable to some one value of that variable. This terminal value, being fixed in the design of the circuit, seems God-given, and consequently is called the canonical position or brightness.

There is still another way of making existential operators and their corresponding universals. Most of our sensations, by nervous connections, map the continuous variables of sense upon a mosaic of relays. Imagine layer upon layer of such mosaics so stacked that the relays form rough columns. Let the incoming signals slant up through the layers. Fix the threshold of each relay so that it will trip only if it receives a signal from the input and a simultaneous signal to all relays of its layer. And, finally, let the signal from each relay descend vertically. If, in such a matrix, a stream of signals comes in over a single slanting input and the layers be successively alerted, the output will move step for step, in the direction of the projection of the slant upon the basic mosaic. Hence, if there be a spatial pattern of input, its form will be translated horizontally in that direction. In this way we make, from something given in one position, the same thing in all positions along any line. Now pitch maps on the auditory cortex so that octaves span approximately equal stretches, and the auditory cortex is such a matrix. There is an ascending and descending pulse gating relays of the cortex, sweeping it every tenth of a second. Hence I believe that we detect chords by making the translations along the axis of pitch while we preserve the interval. In fact, we do detect chords regardless of pitch at about ten per second.

THE VISUAL CORTEX

We know far more about the visual cortex. Here the visual field maps so that the radial distance on the cortex is roughly proportional to the logarithm of the angle from the line of gaze. This cortex is again a matrix, but so specialized that it can be recognized easily. The ascending information in effect radiates toward and from the central point. Hence, in effect, this cortex makes the dilatation and constrictions of the centered figure. Consequently, its output is the same regardless of the size of the figure in the input. Every part of this visual cortex is connected to a host of scattered points in a second visual cortex, hence it comes about that to any figure in the output of the first visual cortex there will correspond by chance some point of maximal excitation in the second visual cortex. The local clipping circuits suppress activity at all points where it is less than the maximum; so the position of maximum excitation determines the output. Again, the sweep of scansion is about ten per second, the so-called "alpha rhythm;" and again, this is the number of shapes that can be seen per second without any blurring or noticeably apparent motion.

From these well-established anatomic and physiologic facts it follows that if one were to stimulate a spot on the first visual cortex of a man's brain exposed at operation he ought to see a blob of light, like a setting sun, somewhere in the visual field and it ought to move when he turns his eyes. That is exactly what men actually report when they are so stimulated. However, if one were to stimulate the second visual cortex with appropriate electric pulses he ought to see a form, like a hand, a house, a tree or the like, and it should not seem to be at any one place in the visual field nor should it move if he turns his eyes, nor should it be of any particular size but merely a shape freed of position and size, and that is just what the patients do report.

These last examples show clearly a process of computing invariants each of which is a sum, for all members of some group of transformations, of the values assigned by an arbitrary functional to the transformations as functions of excitation at points and times in a given matrix. To define universals without any loss of information, one would need a matrix of these invariants, the matrix being of as many dimensions as the original matrix. In practice a much smaller number of invariants usually suffices.

Here it should be pointed out that, in the case of the reflex that centers an apparition, the cerebral circuits actually assign the value zero to all transformations but the last. Thus it, and probably every other device for securing invariants corresponding to universals derived from particulars, is but an example of this procedure. In short, this is a general description of all coding devices. Inasmuch as in relay nets one can convert any figure of pulses at one time over a given number of relays into a figure of impulses over one relay at as many times as it had required relays at one time—and vice versa—one cannot guess how a given universal will be represented in an unknown net, for all one knows is that it must be invariant. Moreover, there is no reason why the same invariant can be abstracted in only one part of a net. Each half of the visual field is represented in the other half of the brain but a man can recognize a straight vertical line in either half equally well. In short, one would have to know in detail the anatomy and physiology of the brain pretty well to guess where to look and what to look for, and he still would not know enough to guess right more than once in a "blue moon."

Actually, however, neither does anyone know the entire blueprint of Eniac, and certainly no one knows whether Eniac actually is wired according to the blueprint. We know from the chemistry of our chromasomes that our genes do not contain enough information to specify all the connections of our nerve cells. These can specify only a moderately complicated secondary machine which must build a tertiary machine, and so on, until the last builds the final brain. The next to last is never completely superseded or separated from the last but remains to tend the machine; and, when any part is busy or out of commission, it shifts the problem to computers that are free to work on it. In this it resembles the differential analyzer at the Massachusetts Institute of Technology. Consequently, it is very difficult for us to discover even gross defects or guess the function of a part from what happens when it is destroyed. Brains may seem to be all right when several parts have ceased to function. Any machine like Eniac, which does many things in parallel, is hard to troubleshoot for the same reason. Parts may fail and answers continue to be computed. But human brains are incomparably worse in this regard. I believe von Neumann thinks that in a minimal nonparallel machine made of a few thousand vacuum tubes one malfunction per four hours is tolerable and this requires that the probability of error in function of a relay must be say 1 in 10^{12} unitary operators, (pip or no pip). The best electromagnetic relays probably fail 1 in 10^9, that is, a thousand times too often. Nerve cells are not that good and they cannot be replaced but they are cheap and plentiful. Hence the worst of our difficulties in trouble-shooting.

THE UNIT OF INFORMATION

A unit of information, as Wiener has suggested, may be described as the decision whether a relay is or is not to fire in one relay-time. In an ensemble of N nerve cells, they can be equally well in any one of 2^N possible states by chance. Every unit of information subtracts one from N. Hence the amount of information is the logarithm (to the base two) of the reciprocal of the probability of the state—or the negative of the entropy of the system. Thus, "entropy never can decrease" means exactly the same as "information never can increase." Actually entropy increases and signals become corrupted on passing through any communication system. Corruption may be defined as the ratio of information in the input to information in the output. Now, consider man. Each eye has a hundred million photo receptors each capable of one decision per millisecond—so input information is at least 2×10^8 per millisecond. Man's output in speech can be estimated by noting that a telephonic device that samples speech once per millisecond and emits one pip or none according to the amplitude of the wave, conveys almost all the original information. Two pips per millisecond, corresponding to four amplitudes, are certainly more than enough. So, from human vision to human speech, the corruption is 10^8. A part of that loss is due to the clumsy coupling of nerve to muscle, but the rest is used to buy security.

The eye contains a hundred million photo receptors which converge by way of bipolar cells on a scant million ganglion cells which relay the signals to the brain proper. By requiring coincidence at each junction, we ignore signals that do not agree with other signals and we do it to the tune of a hundred to one decisions. This means that the brain gets the signal only if it corresponds to a statistically significant number of synchronous responses of the photo receptors. The probability that the signal relayed to the brain is due to chance may be 1 in 2^{100} which is 1 in 10^{30}; negligible to say the least. But the process does not end there. It is repeated at almost every step from input to output. Naturally we make few gross errors of action, but so much calculation in parallel with subsequent demand of coincidence makes it almost impossible to detect trouble in the circuit unless it happens to catch most of the parallel paths for some sequential action. Many a nerve cell can, and does, die and no one knows it till he sees that brain under the microscope. These scattered losses rarely bring us to the doctor.

THE NEUROTIC BRAIN

It is far otherwise with neuroses. As was noted previously, the dynamic stability of normal living is maintained by negative feedback. When for any reason, say environmental stress, the gain increases, these change to positive feedbacks, oscillating regeneratively at their normal frequencies; also, when for any reason they are driven at a frequency at which the gain exceeds one, they become regenerative. Kubie was the first to call attention to the reiterative core of every neurosis, and he was right. All evidence now indicates that neuroses begin in some normally negative feedback going regenerative, persisting in activity throughout every minute, day and night, for months and years. It tends to sweep more and more cells into its orbit and so removes them from their normal function as free-floating computers. This enfeebles us for certain intellectual tasks, and fixes our behavior in ill-adapted ways. Cells swept into its orbit and fired often suffer fatigue, a rise in threshold, and constitute a wall about the process so that other activities cannot communicate with it. Eventually, by repetition, it affects the cells so that the pattern of their activity reappears even after it has been interrupted, in this resembling all our motor skills. In early periods it is enough to interrupt the reverberation again and again and sweep the other cells out of its orbit, but when it invades the major organs of judgment and becomes obsessive or compulsive it may require a surgeon's knife to cut the feedbacks of the frontal lobe. Thereby we sacrifice many of the highest traits of character, some kinds of insight into things and men, and, in addition, the ability to create new categories among ideas.

In the neurotic brain you may find no general chemical reaction gone astray, nor any damaged cells, for when activity ceases, regeneration ceases. The most you might expect to find are some changed thresholds or connections—those little invisible differences which each of us acquires by use—the basis of our characters. The more we build negative feedback into machines, the more surely they will have neuroses. These diseases are demons with ideas and purposes of their own. Physicists have been known to curse them but they cannot be exorcised. If, instead of our variety of psychodynamic nonsense, you wish to think sensibly of them I would suggest, in all seriousness, that you start now to prepare a dimensional analysis of gremlins.

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Gas Turbines for Power Generation and Other Applications

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MEMBER AIEE

This article describes two gas turbines designed for power generation. Also, a number of other possibilities for gas turbine use are presented to indicate the wide field to which the present units are adapted and to show the general present state of development.

THE GAS TURBINE, as in the case of most prime movers, has had a rather long history. It is, however, a type of prime mover that only now is being reduced to a form suitable for practical applications. A gas turbine may take a great many forms; and throughout the world many designs have been built and are in operation, and many more are under way. These range from the simplest type to very complex cycles, which may involve both reciprocating and rotating equipment. Each type has many attractive features and may fit a particular application to a great advantage.

A great deal has been written concerning the broad field available to the gas turbine as its development progresses. It does seem to be a type of power plant which will prove to be of wide usefulness; however, it can justify its adaptability in two ways. First, even the simplest type of plant is attractive for many applications without changing the basic unit; second, as the over-all development progresses, more new types should become available with their own particular fields of superiority.

One important aspect of the gas turbine, sometimes partly lost sight of among the glowing predictions for its future, is that so far there has been very little experience with it for general power purposes. Aside from process units designed which were for low temperatures, no really extensive operating experience has been reported anywhere.

During the war, two aircraft gas turbines of the axial flow type were developed by the General Electric Company. Each is of the simplest type with one turbine, one compressor, and no intercooling or regeneration. The *TG-100* has had many flights up to high altitude and has given a very good account of itself. The *TG-180* (Figure 1) and its successor, the *TG-190*, are being used in a majority of new jet fighters and bombers of the Army Air Forces.

Based on this experience, but recognizing the difference in requirements for nonflying applications, a simple power plant with a design rating of 4,800 horsepower (at 1,500 feet altitude) has been designed, built, and tested at the General Electric Company. This power plant was designed particularly for locomotive applications, but with recognition that it should be attractive also for many other

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Full text of paper **49-114**, "Two Gas Turbines for Power Generation and Other Applications," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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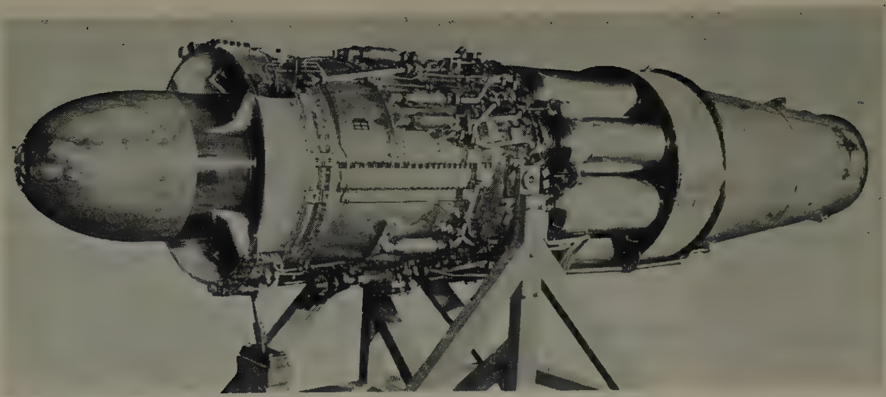


Figure 1. Axial-flow-type aircraft gas turbine for jet propulsion

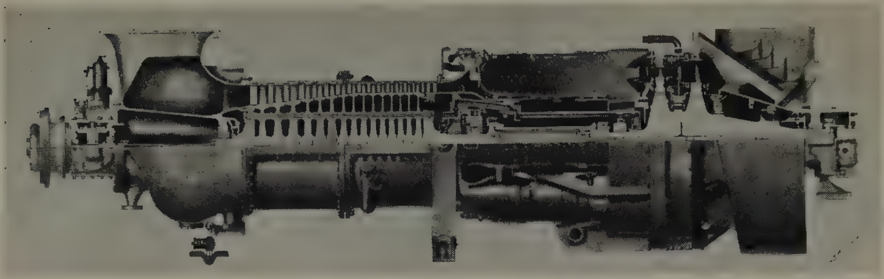


Figure 2. Semi-cross section of a 4,800-horsepower gas turbine for locomotive drive which is approximately 19 feet long, and weighs about five pounds per horse-power

types of installation. Figure 2 shows a cross section of the unit, which is approximately 19 feet long, and weighs about five pounds per horsepower. Figure 3 shows the unit on test in Schenectady, N. Y., where it drove four d-c generators of the traction type through gearing.[1] The power plant proved to more than meet its design rating, and to be a little better in efficiency than the design predictions of 17 per cent based on net shaft power and the lower heating value of the fuel. More than 700 hours of operation have been accumulated. Some difficulties were encountered, of course, but these were not of a basic nature. Simple corrective measures were taken, and the over-all operation has been considered very definitely encouraging. A majority of the running was on Bunker "*C*" (number 6) fuel oil, and a total of more than 230,000 gallons of this low-grade fuel has been burned.

The characteristics of this plant, based on the tests, are shown in

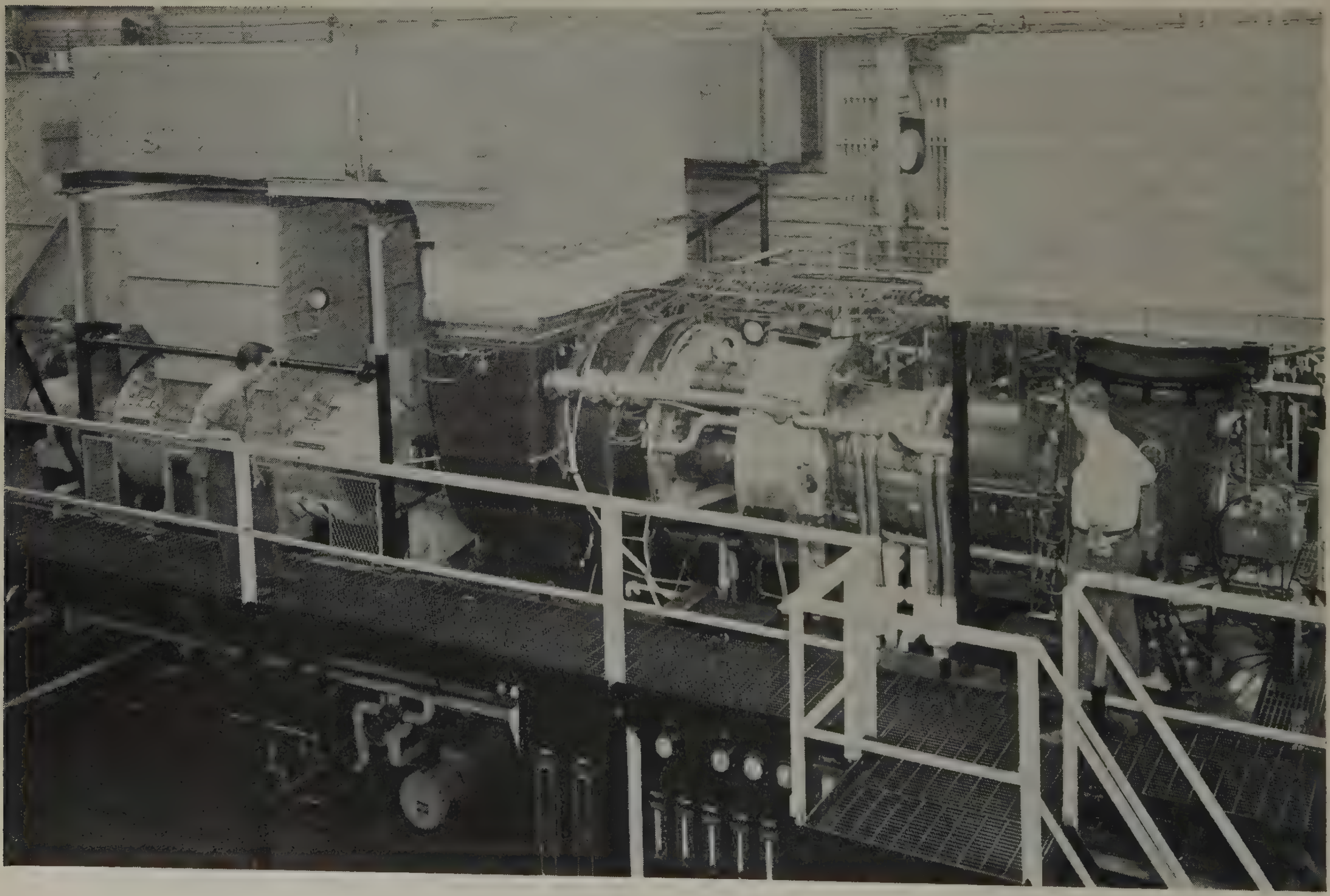


Figure 3. Arrangement for test of 4,800-horsepower gas turbine for locomotive drive

Figures 4 and 5, while Figure 6 shows the effect of altitude. It will be seen that there is a definite effect of ambient temperature and of altitude. In these characteristics, the gas turbine is different from either steam plants or diesel engines, and its features should be evaluated for each application. In cold weather the power output obtainable increases substantially, whereas in hot weather the output falls off with exhaust temperature maintained constant. In dry locations, evaporative cooling of the inlet may be quite attractive since the wet bulb temperature always may be attained. This will require approximately 1,500 to 2,000 pounds of water evaporated per hour. In at least one application the incoming air will be cooled by a surface cooler.[2]

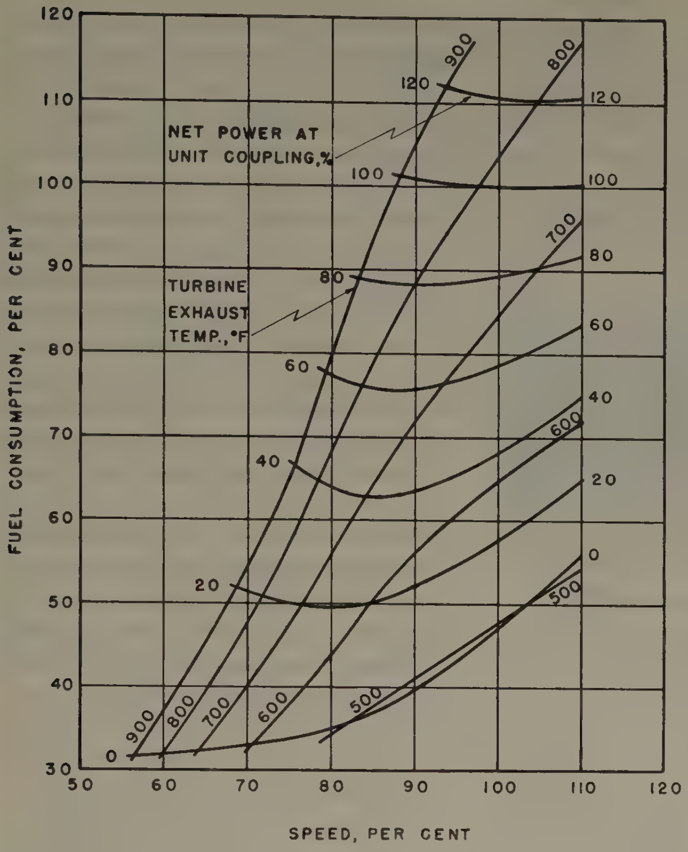


Figure 4. Tested thermal performance of a 4,800-horsepower gas turbine power plant; 100 per cent values correspond to 75,600,000 Btu per hour, 6,700 rpm, and 5,000 horsepower at sea level and 80 degrees Fahrenheit ambient temperature

The exhaust temperature of the turbine varies with load and with ambient temperature, and the air flow also varies. This results in a variation of the heat available in the exhaust as shown in Figure 5. This basic natural characteristic can be modified by the combustion of additional fuel in the exhaust gases prior to entering the waste heat boiler, or by throttling on the compressor inlet or turbine discharge to raise the exhaust temperature at a given load. Of course, in doing this, the turbine exhaust temperature cannot be raised above the maximum permissible value in such cases.[3]

Based on this successful operation, the power plant has been installed in a locomotive and, at present, is undergoing preliminary track tests. Furthermore, two of these power plants have been sold to public utilities for power generation purposes. In one of these applications, the fuel is natural gas, and the exhaust will be used to heat the feed water of the existing steam power station in which the unit will be located. This application illustrates one of the adaptable features of this unit.[2]

With this simple-type plant, the over-all efficiency is of a moderate value which indicates that the major application is expected to be where fuel is inexpensive, the utilization of the waste heat is desirable, or small size and light weight are important.

This type of power plant requires cooling water only for lubricating oil and even this can be dispensed with by the use of air-cooled radiators, if desired, so that the unit is particularly attractive where cooling water is difficult to obtain.

Since the power plant is relatively small, compact, and light in weight; simple, inexpensive foundations and housing are required, thus resulting in economical installations.

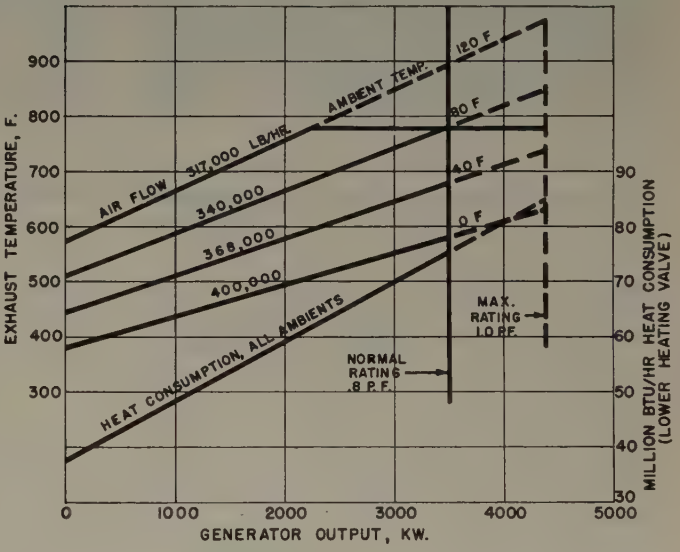
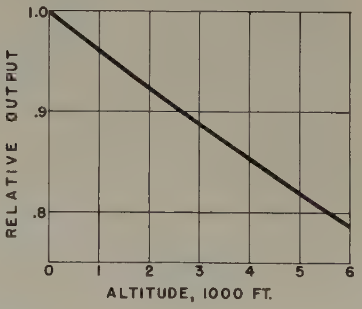


Figure 5. 3,500-kw gas turbine-generator estimated performance at sea level

Figure 6. Effect of altitude on output and air flow



An attractive possibility for this simple unit is as a portable power plant. While the details of this have not been fully developed, it appears likely that the generating plant could be put on one flat car with the fuel oil brought up in tank

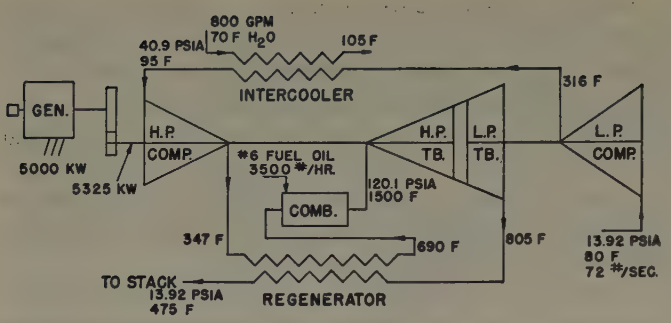


Figure 7. Cycle diagram with pertinent pressures, temperatures, flows, and output for design rating at 1,500 feet altitude and 80 degrees Fahrenheit

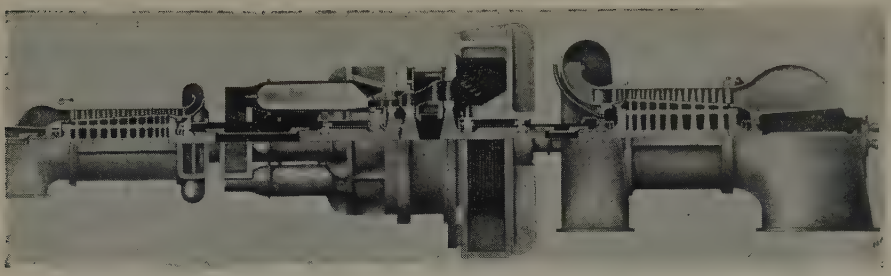


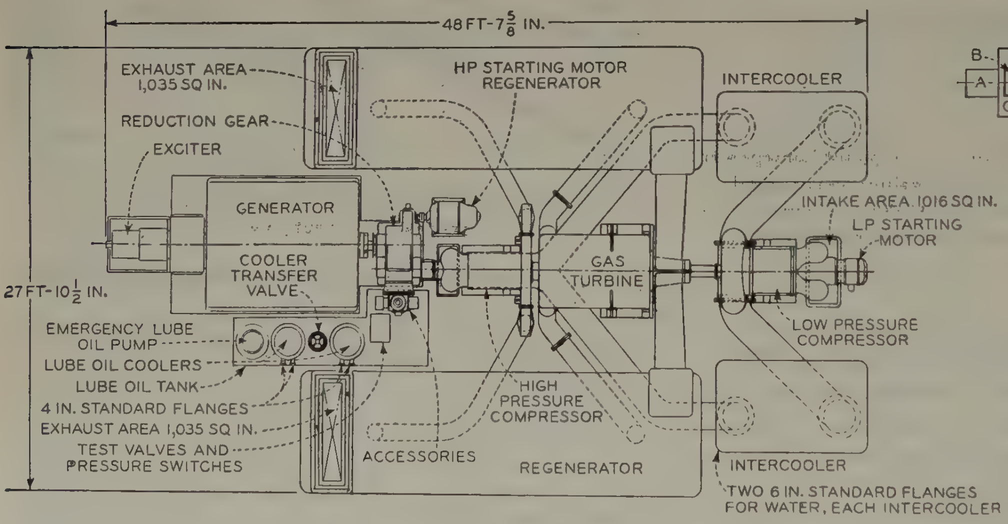
Figure 8. Cross section of a gas turbine for 5,000-kw turbogenerator set

An entire unit of this type can be contained in a space approximately 50 feet long by 28 feet wide by 13 feet high; the weight is approximately 60 pounds per kw

cars. Similar portable power plants well might form emergency units for pipe line pumping spares and probably could be transported in one or two trucks.

Other attractive applications for this plant should be in industrial power, gas or oil pipe-line pumping, or where the exhaust heat is used directly as, for example, in the drying of lumber.

For many applications, particularly in the usual power generation case, a higher efficiency than can be obtained with the simple cycle, both at full load and at part load, is desirable. Such increases in efficiency are obtained in the gas turbine primarily by using heat transfer elements in the form of intercoolers between stages of compression and regenerators, making use of the turbine exhaust heat to preheat the air entering the combustion chambers. Figure 7 is a diagram of such a power plant cycle including temperatures and pressures at the various points in the cycle under the design conditions of 1,500 feet and 80 degrees Fahrenheit. Figures 8 and 9 show an approximate cross section of the machinery and an installation outline. It will be noted that both the regenerator and intercooler consist of two units in parallel, and that the entire power plant is contained in a space approxi-



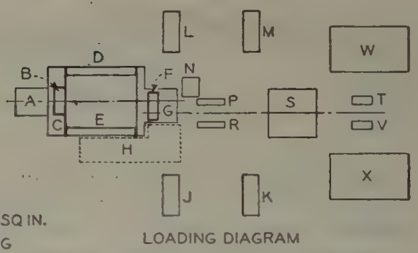


TABLE OF LOAD DISTRIBUTION

AREA	POUNDS	AREA	POUNDS
A	2,100	L	35,000
B	5,000	M	35,000
C	1,000	N	2,400
D	20,000	P	3,000
E	20,000	R	3,000
F	6,000	S	19,000
G	6,000	T	6,000
H	18,000	V	6,000
J	35,000	W	10,000
K	35,000	X	10,000

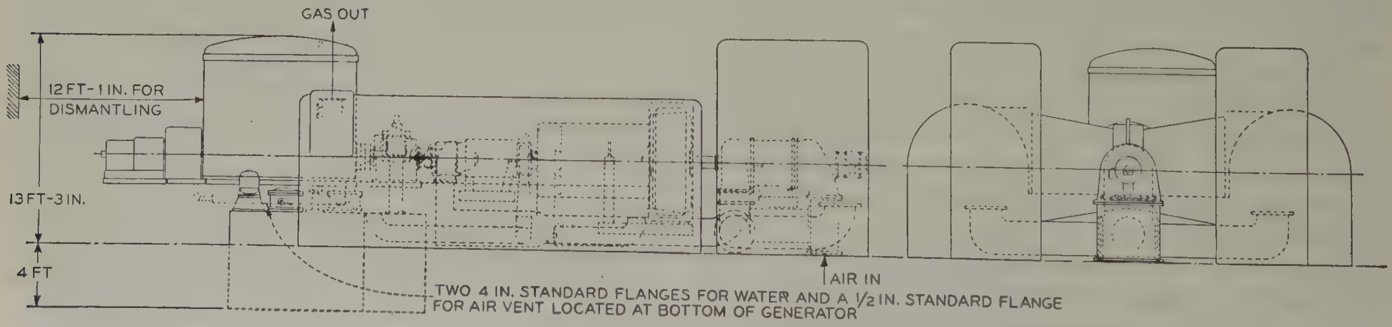

GAS OUT
12 FT-1 IN. FOR DISMANTLING
13 FT-3 IN.
4 FT
AIR IN
TWO 4 IN. STANDARD FLANGES FOR WATER AND A 1/2 IN. STANDARD FLANGE FOR AIR VENT LOCATED AT BOTTOM OF GENERATOR

Figure 9. Installation outline of main machinery and heat exchanger components. Both the regenerator and intercooler consist of two units in parallel, and the entire power plant is contained in a space approximately 50 feet long by 28 feet wide by 13 feet high

mately 50 feet long by 28 feet wide by 13 feet high. The total weight is expected to be around 60 pounds per kilowatt.

The turbine and compressor are divided into high- and low-pressure elements primarily to provide improved heat rate at reduced loads. At part load, the low-pressure turbine and compressor will run at reduced speed, thus maintaining better cycle efficiency.

This power plant is now under construction, and the first of its type is expected to be in factory test operation within a few months.

It is designed for 5,000-kw generator terminal output and has an expected thermal efficiency of 28 per cent based on the generator terminal output and on the lower heating value of the fuel. In comparison this is a better efficiency than can be expected from steam stations of comparable size.

The mechanical design, also gave the anticipated performance characteristics, as shown in Figure 10. From this figure, it will be seen that the normal rating of the power plant is affected by ambient temperature as in the case of the simple type of power plant, but at a lesser rate. It is basically affected by altitude as shown in Figure 6, which applies approximately to any gas turbine. Relative to the normal rating, the maximum expected net output is about 15 per cent greater, which means that the full 5,000-kw net output should be maintained up to about 110 degrees ambient temperature. The part-load heat rate is higher than at full load, but increases relatively slowly as the load is reduced, so that at half power the heat rate should be only about 16 per cent higher than at full power.

This power plant requires relatively very little cooling water compared to a steam station of a similar rating. Normally, a total water flow of approximately 1,200 gallons per minute would be required for intercoolers, oil coolers, and generator air coolers. This is compared with about three to five times this value for a steam station. In addition to the good thermal efficiency and low cooling water requirements, this power plant is expected to have a relatively low installation cost. The version shown is essentially a one-level plant, with only the oil tank required to be below floor level.

The inlet duct to the low-pressure compressor and the exhaust openings from the regenerators normally would include simple sound-absorbing means to suppress the high-frequency-turbine and compressor noise. If desired, the regenerators can be left out, and the turbine exhaust heat can be used for making steam or for other purposes rather than preheating the combustion air. In this case, as could be expected, the fuel rate would be increased by about one-third.

It is expected these plants should be attractive for end of line installations, and for standby and peak load operation where the quick starting feature would be of particular advantage. It is expected that completely automatic operation will be quite feasible.

As in the case of the 3,500-kw unit, this 5,000-kw plant is designed to be adaptable to the burning of a light or heavy fuel oil, including Bunker "C", and to the combustion of gas. At the present time, three of these units have been ordered for installation in power stations, and two of them will burn natural gas while the other will burn Bunker "C" fuel.

In summary, a large-scale gas turbine developmental program is under way, including many component developments not outlined in this article. This development has resulted, so far, in the construction and test of the simple-cycle locomotive-type plant, the design and current construction of the high-efficiency 5,000-kw unit, the receipt of orders for both types of power generation, and the installation of the locomotive unit in a locomotive with preliminary track tests underway.

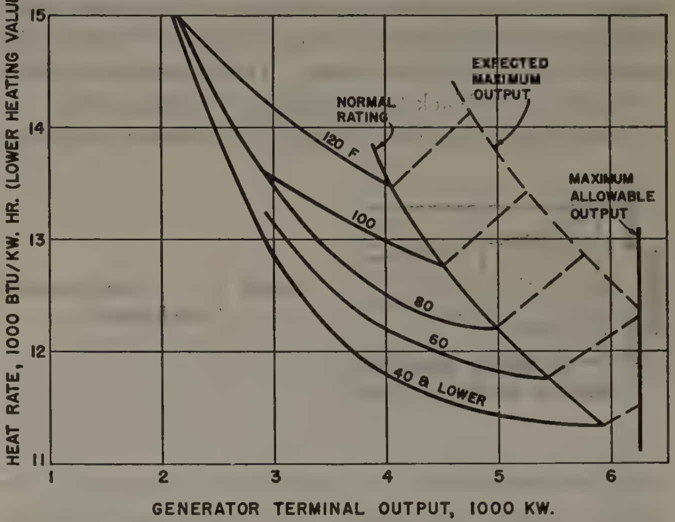


Figure 10. **Estimated plant heat rate, based on lower heating value of gas or liquid fuel versus generator output and ambient temperature at 1,500 feet altitude**

This is all undertaken in the belief that the gas turbine will find wide use. However, it is not believed that it will displace in the near future other forms of prime mover, such as large steam turbines.

In this article, a full description of these two power plants and their possibilities has not been attempted. It is hoped, however, that sufficient possibilities have been outlined to indicate the wide field to which the present units are adaptable and to indicate the general present state of development of the gas turbine. It is anticipated that in the future other sizes and types of gas turbine will become available, and that experience with the present plants will prove them to have low maintenance and to be reliable and economical when properly applied. It is also anticipated that as developments progress, it soon will be possible to use coal as a fuel for gas turbines which should extend their field of usefulness considerably.

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An Instrument for Measuring Commutation

R. T. LUNDY

"BLACK BANDS" have been used for many years to compare the commutating ability of d-c machines and to set the brushes in the proper place. A black band, as used here, is defined as the number of amperes by which the current through the commutating winding can be changed without producing sparking at the brush faces. This band width usually is taken at 25, 50, 75, 100, 125, and 150 per cent of rated load. This is plotted as shown in Figure 1, the black band being the shaded portion.

When developing new brushes, it is necessary to have a fairly fast and accurate way of comparing the commutating ability of the various brushes. Black-band tests seem to be the best way of making this comparison. In our studies, we used the black-band width at full load only, as more consistent results were obtained and less time required.

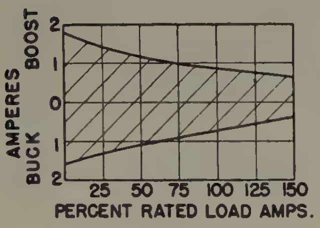

Figure 1. Representative "black band"

Since it is difficult for different individuals under various lighting conditions to duplicate results by the visual sparking method, a search was made for an indicating instrument. A cathode-ray oscilloscope, a radio noise meter, and several models of electronic voltmeters were tried. The oscilloscope was used mainly for studying the nature of the disturbance. The results obtained with the radio noise meter and one of the electronic voltmeters check very well with those obtained by visual sparking. The other electronic voltmeters were unsatisfactory for this purpose, because of their lack of sensitivity at high frequencies. The meter giving the best results is a peak-reading electronic voltmeter having a frequency error of less than one per cent between 20 cycles and 50 megacycles.

Most of our evaluation of commutating ability of various brush grades has been done on a variable-speed 10-to-15-horsepower machine. This machine was direct-driven as a generator at 1,800 rpm and delivered a full-load current of 58 amperes to a load bank. To eliminate as many variables as possible, the machine was set up in our altitude chamber where a relative humidity of 35 per cent at 85 degrees Fahrenheit could be held.

Each test was started on a raw commutator. Brushes were carefully sanded to fit the commutator and finally seated with white seater stone. Hourly readings were taken with the electronic voltmeter and plotted against the corresponding amperes buck or boost in the commutating winding. Amperes buck or boost were changed in half-ampere steps starting at the middle of the band and going in the buck direction until a voltmeter reading of over one volt was obtained, then returning to the middle of the band and increasing the boost current to the same limit. From this family of curves (see Figures 2 and 3), an average band width at one volt was obtained. The comparison was made at one volt on this machine because the curve had definitely turned up and sparking was evident at this point.

Since the electronic voltmeter is connected across the terminals of the generator, it shows sparking on all the brushes with one reading. This is much better than having to look at each brush, as in the visual method of obtaining black bands. On some machines, it is physically impossible to look at all edges of all the brushes. Also, using the electronic voltmeter eliminates the variations due to different observers and to different lighting conditions. Some precautions must be taken when using the indicating instrument as a commutation meter. Erroneous results may be obtained if the generator supplying the buck and boost current sparks, as the disturbance will follow the wires to the voltmeter. Also, sparking of a parallel generator may cause trouble if not blocked out with a filter.

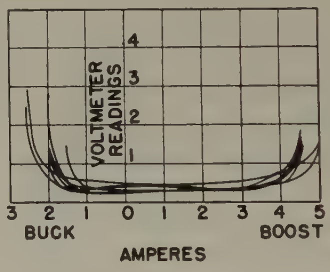

Figure 2. Representative voltmeter band with a very good commutating brush

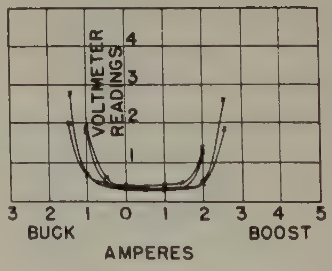

Figure 3. Representative voltmeter band with a poor commutating brush

This accurate method of comparing commutation should be useful in production tests for setting the brushes, checking the pole shims, and making sure each machine is within design limits. It also can be useful in development work.

Digest of paper **49-31**, "Measuring Commutation With an Indicating Instrument," recommended by the AIEE rotating machinery committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Not scheduled for publication in AIEE *TRANSACTIONS*.

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A New Lightning-Measurement Technique

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MEMBER AIEE

LIGHTNING is very erratic in nature and plans for measurements must be made with extreme care. Two methods of lightning-current measurement were used successfully in a 4-year study on a rural distribution line and the results obtained are described in a recent paper.[1]

Seven oscillographs were used to measure lightning currents in arresters or transformers. Each oscillograph has two 3-inch cathode-ray tubes mounted close together, so that a single lens focuses both traces on a $3^{13}/_{16}$-by-31-inch film wrapped on a drum rotating once every 0.7 second. After an exposure, the drum automatically shifts axially so that four distinct records can be obtained. Figure 1 shows the disposition of the cathode-ray tubes, lens, and film-driving mechanism. The oscillographs operate from a 115-volt 60-cycle source. Special nonlinear shunts, combining Thyrite and wire-wound resistors, permit accurate measurements of current over a 50-to-1 range. The beams are turned on by means of a thyratron when the current is great enough to produce a record. An oscillating voltage is applied to the grid of the thyratron so that it trips regardless of the polarity of the lightning current. The beams go off after about two revolutions and the drum automatically is shifted axially, making ready for another stroke. Four or more exposures can be taken on a film, but there may be multiple exposures on the last position.

Each oscillograph is energized from a battery-driven dynamotor so that records can be taken during power failures. The sensitivity of the oscillograph is made substantially independent of battery voltage by using a ballast tube in series with the cathode-ray transformer.

It is highly advantageous to be absolutely certain that the initiating and measuring circuits are in good condition. Hence, provision is made to check these circuits after the final installations. A special calibrating box can be connected to any of the oscillographs and provision is made to supply to the deflecting plates 35 or 70 volts, rms, 60-cycle, or 22.5, 45, 67.5, 90, or 112.5 volts, d-c. A dry cell, push button, and small step-up transformer are mounted in the same box and used to check the initiation of either circuit. Suitable switches are provided on the box so that all the checking can be done quickly and easily. At the start of each season, an additional over-all check on the oscillographs was made, using a portable impulse generator.

Magnetic links are used in pairs to measure the crests and per cent reversal of lightning currents. For accuracy, such as attained in the rural-line investigation, technique refinements of a laboratory caliber are needed, and a special table is built up to calibrate individually both links (of a pair) simultaneously.

The steps taken for such calibration are outlined as follows:

1. After every storm, the links are checked on location with a sensitive compass detector, and all links showing magnetism are brought in to the special table for calibration.

2. Each link in turn is inserted in a small coil which then is connected in series with a ballistic galvanometer. The link is pulled out rapidly and the galvanometer throw is recorded. If off scale, the test is repeated using a tapped attenuator. All steps give approximate critical damping. The coil is swivel-mounted and its axis set perpendicular to the earth's field to avoid induction effects.

3. Each link is demagnetized by withdrawing it from an a-c energized coil, also lined up perpendicular to the earth's field.

4. Two calibrating coils, each with 2,080 turns and an average diameter of 5.3 inches, are mounted about three feet apart on the table. Two capacitor banks can be charged up to the same voltage and discharged into their respective coils with resistance adjusted to avoid oscillation and to obtain the proper ratio of crest currents for the inner and outer links. This method of calibration avoids coil overheating, gives ample time to read the original voltage, which is a measure of the crest current, and the power pack can be operated from any 115-volt source. The two links are put in their proper coils and the capacitor banks charged up to a voltage corresponding to the operator's estimate of the currents required to give the original retained magnetism.

5. From here on, it is a "cut-and-try" process, usually with several complete cycles of magnetization, measurement, and demagnetization, and often the necessity of applying a second reversed discharge of reduced intensity in order to duplicate the original results.

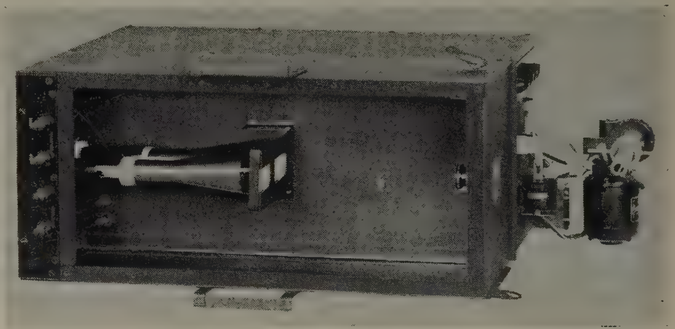

Figure 1. Oscillograph with top cover and film drum housing removed

These steps take considerable time, but the accuracy is much greater since there are no errors resulting from magnetic variations among the individual links. Using the special table, an experienced operator can handle about 12 pairs of links per hour. With the link spacings used, crest currents from 100 to 30,000 amperes can be measured with an accuracy of about ten per cent.

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Electrical-Insulation Contaminants

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SERVICE EXPERIENCE with electric apparatus has indicated that in many cases the presence of "contaminants" has contributed to the failure of electrical insulation. In the category of contaminants are included moisture, salt, oil, carbonaceous materials, and dust. Such contaminants may adversely affect both the physical and electrical properties of electrical insulation.

The General Electric Company under contract to the Bureau of Ships, United States Navy Department, has undertaken a program to develop laboratory test methods suitable for determining the effects of contaminants on electrical insulation. It is apparent that such tests, to be significant, must be applied to insulating materials in the form in which they appear in actual apparatus. Consequently, it is best to develop test samples which consist of insulating materials in combination and which are characteristic of the combinations found in actual apparatus. This approach to the insulation problem has not previously been considered in the writing of material specifications. There are two types of specifications for electrical insulating materials in common usage:

1. *Material Quality-Control Specification*—which specifies tests on standard specimens and properties of the insulating material as manufactured to determine that it is of the same quality as material previously found satisfactory by tests on the electric equipment in which it is used.

2. *Equipment Specification*—which specifies tests on and properties of the insulating materials indirectly by stipulating tests on and properties of the complete electric equipment in which the insulating materials are used.

It would be of obvious advantage to both insulating-material and electric-equipment manufacturers if means existed to predict, in advance of tests on the electric equipment itself, that the insulating material would be satisfactory in that equipment.

Material quality-control specifications alone do not serve this purpose adequately. The principal reason for the inadequacy is the fact that insulating-material quality-control tests are conducted and properties determined on the material as manufactured, whereas in actual equipment, such materials are used in combinations where design and construction factors play important roles not completely represented in the material quality-control tests and properties. There exists, therefore, a need for an additional type of specification:

3. *Simulated Component Specification*—the purpose of which is to determine the suitability of insulating materials in advance of tests on the complete equipment. This type of specification would give the tests to be conducted and properties to be determined on combinations of electrical-insulating materials in a form simulating the design and construction in which the combination would occur in the electric equipment.

It is obviously impossible to simulate in a test program the wide range of composition and character possible in each type of contaminant as it occurs naturally. Moreover, the infinite variety of ways in which the contaminants actually may be deposited cannot be reproduced in tests, and an arbitrary method of applying the contaminants must be developed. However, the arbitrary materials and methods developed must be as representative as possible of actual service conditions with a tendency to emphasize the combinations and methods which produce the greatest deterioration. The development of the contaminants and methods of application actually has been carried out essentially by a process of "backing and filling." The results of the tests on the physical and electrical properties of contaminated insulation with arbitrary contaminants has led to the formulation of different contaminants which in turn were evaluated electrically and mechanically.

Only the liquid contaminants have been used in studying physical properties since it was believed that the solid contaminants could have relatively little, if any, effect. After trials with various methods of applying the liquid contaminants, total immersion in the liquid (hot or at room temperature) was adopted for most of the work as the easiest, most uniform, and in most instances the most severe method. However, for the more volatile oils and fuels, results indicated that the vapors from the hot liquid in some cases might produce greater deterioration than immersion. In order to survey the effect of contaminants on electrical properties, simple rectangular plastic samples with bolts and washers for electrodes were used.

A number of methods have been developed for evaluating the deteriorating effect of contaminants on both physical and electrical properties of insulating materials. The results bear out the need for testing samples which are a combination of insulating materials.

The large number of factors which enter into such evaluations is most striking. In consequence, the development of significant and useful material specifications covering the effect of contaminants on insulating materials appears to be difficult. It is likely that the methods described will be most useful at first in carrying out evalutions, which it is hoped may serve as a guide to the design engineer in his choice and use of insulating materials. Additional work is being done to learn more about the problem, eliminate unnecessary variables, and simplify tests. At the same time, results with the methods described are being correlated with service experience. Eventually, it may be possible to write material specifications which include the effect of contaminants on insulating materials in combination.

Digest of paper 49-35, "Methods for Determining the Effects of Contaminants on Electrical Insulation," recommended by the AIEE rotating machinery committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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Multifrequency Pulsing in Switching

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Applications of multifrequency pulsing in switching are described in this article. Today, many installations of this type are being made in cities throughout the nation. This system permits operators or senders to complete calls to crossbar offices without the aid of other operators.

MULTIFREQUENCY pulsing is a form of signaling with alternating current which permits the rapid transfer over telephone trunks of the information required to select switch paths in local, toll, and tandem dial telephone systems. The multifrequency pulses consist of different combinations of two, and only two, of six frequencies. These six frequencies are spaced 200 cycles apart, from 700 to 1,700 cycles, inclusive. Each combination of two frequencies represents a pulse, and each pulse a digit. The pulses are sent over the regular talking channels and, since they are in the voice range, are transmitted as readily as speech. There are 15 pairs of frequencies possible from the group of six; ten of them are used for the digits 0 to 9, inclusive, and one each for signals indicating the beginning and end of pulsing. The remaining three possible pairs are available for future requirements.

The multifrequency system is arranged so that if more than two frequencies are received by the equipment, the operator who is setting up the connection receives a flashing cord lamp; then she must release the connection and start making the call over again.

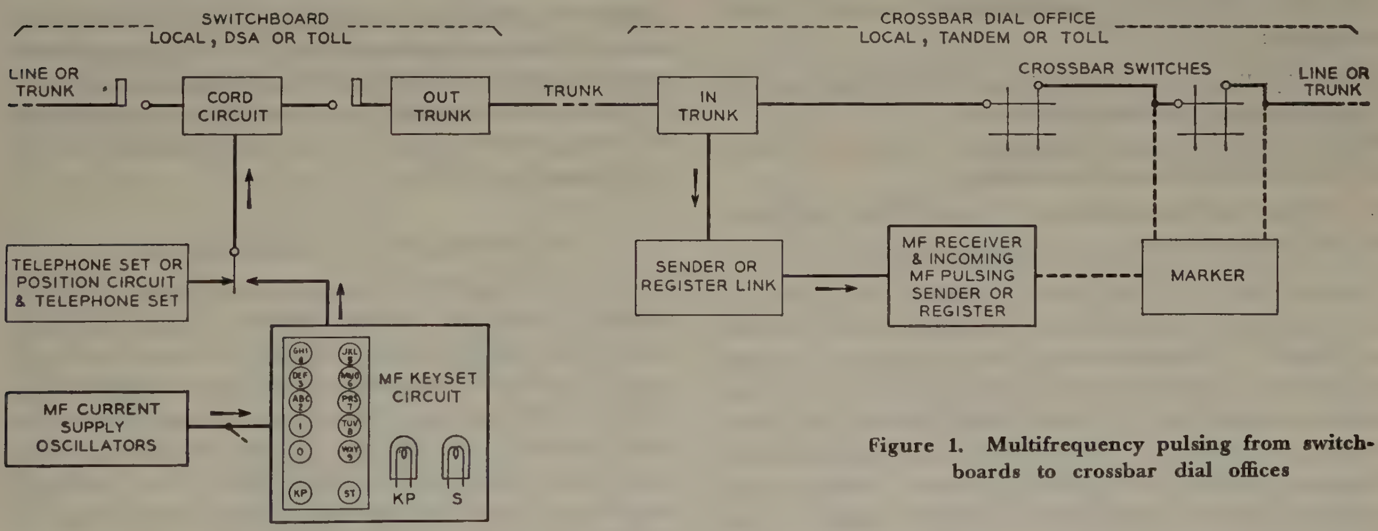

Figure 1. Multifrequency pulsing from switchboards to crossbar dial offices

The first multifrequency pulsing system was installed at the toll board in Baltimore, Md., to permit the toll operators to complete calls to local crossbar offices without the aid of another operator, and without the use of senders in the toll office. Multifrequency pulsing next was used in connection with the new toll crossbar office installed in Philadelphia, Pa. In this installation calls were received over toll lines from distant points, as well as from switchboards within the city, by means of the multifrequency pulsing system. Today, installations of multifrequency pulsing arrangements are being made in many cities throughout the nation.

APPLICATIONS OF MULTIFREQUENCY PULSING

In applying multifrequency pulsing to the telephone plant, it must be kept in mind that the signals used in completing a normal connection in any of our dial telephone systems conveniently fall into two classes: supervision, and pulsing. Supervision includes the connect and disconnect signals going toward the called end, and the "on" and "off" switchhook signals going toward the calling end. The supervision signals can be used under certain conditions for other purposes; for example, to control the start of pulsing, and to recall an operator who may have been assisting in the establishment of the connection. The supervision channel must be ready at once to transmit signals and, therefore, the supervision signaling equipment is provided individually to the trunk. On the other hand,

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Full text of paper 49-101, "Application of Multifrequency Pulsing in Switching," recommended by the AIEE communication committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

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pulsing signals are required only to set the switch paths and are sent toward the called end. Once the switch paths have been set, there is no longer any need for the pulsing channel, so the use of pulsing signals is limited to the time during which the connection is being established. Accordingly, the equipment used for pulsing can be detached from the connection as soon as it has been set up. In the case of multifrequency pulsing, therefore, the pulsing means are detached from the connection at both ends of the circuit as soon as the switching paths have been properly established.

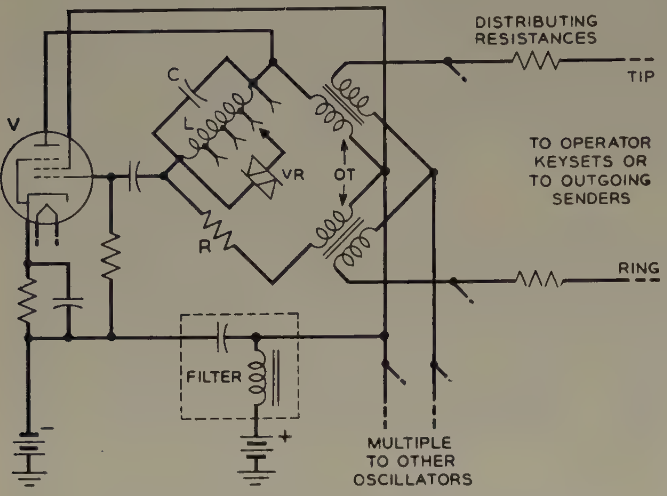
DISTRIBUTING RESISTANCES
TIP
C
L
V
VR
OT
R
TO OPERATOR KEYSETS OR TO OUTGOING SENDERS
RING
FILTER
−
+
MULTIPLE TO OTHER OSCILLATORS

Figure 2. Bridge stabilized oscillator schematic

Over-all Plan. The multifrequency pulsing system consists of:

1. The signaling current supply units and distribution arrangements with suitable protection and alarm features.
2. The signal transmitters, either manual multifrequency keysets or dial system multifrequency pulsing senders.
3. The signal receiver connected to the incoming sender or register.
4. The necessary additional maintenance facilities.

One arrangement of the system components for pulsing on a trunk between manual and dial system offices is shown on Figure 1. A local manual, dial system "*A*," or toll switchboard equipped with multifrequency key pulsing is shown connected by a direct trunk arranged for multifrequency pulsing to a crossbar office equipped with incoming multifrequency pulsing senders. When an outward operator at a manual switchboard handles a call which can be completed through the crossbar office, the first action is to connect a cord circuit to the trunk with the "talk" key operated and operate the *KP* (key pulsing) button of the keyset. The operation of the *KP* key operates a relay that transfers the cord from the telephone set to the keyset, lights a positional *KP* lamp, and prepares the keyset circuit to send the key pulse signal over the trunk as soon as the distant end signals that it is ready to receive pulses. Connection of the cord to the trunk gives a connect signal to the distant end which returns "off-hook" supervision to delay pulsing until a sender is found. When the sender at the distant end has been found, and the pulsing path has been completed, the supervision is changed to "on-hook" as a start pulsing signal. This causes the *KP* pulse signal to go out automatically and lights the positional sender lamp.

Receipt of the *KP* signal at the distant end prepares the multifrequency receiver to accept the digits that are to follow. The operator may begin sending the digits of the called number as soon as the positional sender lamp is lighted. She will do this by pressing one button for each digit. Following the last digit, she presses the *ST* (start) button to indicate the end of pulsing. In addition to informing the distant sender that no more pulsing signals are coming, the operation of the *ST* key disconnects the keyset from the cord, reconnects the telephone set under control of the "talk" key, and also extinguishes the *KP* and sender lamps. If the operator presses two buttons simultaneously, or if she presses the *KP* key after the positional sender lamp lights, a reorder signal is received from the distant end causing the cord supervisory lamp to flash, requiring the operator to release the connection and start the call over again.

Other Applications. In addition to the use of multifrequency pulsing from manual positions to local, toll, and tandem crossbar offices, there is also a wide use of multifrequency pulsing between the incoming senders at the toll crossbar switching offices and the local crossbar offices. In this case, the multifrequency pulses are sent out by a sender, instead of by a keyset. The rate of sending averages about seven digits per second, instead of the two digits per second normally keyed by the operators.

The toll crossbar and certain local crossbar offices are equipped to transmit, as well as receive, multifrequency pulses. A further application to toll switchboards has resulted in the use of multifrequency pulsing senders which will receive multifrequency pulses and transmit dial pulses. This arrangement is used to set up connections to the step-by-step type of office.

MULTIFREQUENCY CURRENT SUPPLY

The current supply circuit consists of two groups of bridge-stabilized oscillators. Each oscillator group normally supplies one-half of the office load, but each oscillator group is capable of carrying the whole office load if failure occurs in either group. Each group consists of six oscillators operating at the frequencies 700, 900, 1,100, 1,300, 1,500, and 1,700 cycles, respectively. The oscillator design is such as to provide constant frequency and amplitude output for normal variations in power supply and output load.

Description of Oscillator. One of the bridge-stabilized oscillators is shown schematically in Figure 2. It consists of a high-gain pentode vacuum tube *V*, operated as a class *A* amplifier, together with a frequency and amplitude controlling bridge. Two arms of the bridge are formed by the high windings of the output transformer *OT*. The third arm is an antiresonant circuit consisting of retardation coil *L* and capacitor *C* connected in parallel, while the fourth arm is a resistance *R* having a value slightly less than the impedance of the antiresonant circuit at the oscillator frequency. Part of the retardation coil is shunted by a thyrite varistor *VR*, whose impedance is responsive to amplitude variations. For low voltages, the varistor has a very high effective resistance but its value decreases rapidly as the amplitude of the voltage is increased. Taps are provided to allow adjustment of the output voltage at the time of installation.

For the normal frequency F_o and output voltage E_o, the impedance of the antiresonant network is resistive and slightly larger than the resistance arm of the bridge. Thus a small voltage unbalance is applied to the grid of the *V* tube and the oscillations sustained. For frequencies above or below F_o, the antiresonant circuit reactance becomes capacitive or inductive, respectively, the magnitude of the reactance depending on how far the frequency shifts from the antiresonant frequency. These effects of frequency upon the phase angle of the impedance near antiresonance, and of amplitude upon the magnitude of the antiresonant impedance are used to stabilize the frequency and amplitude of the oscillations.[1] The frequency control exerted by the tuned circuit depends upon the fact that the phase shift of the amplifier tube must be equal and opposite to that through the bridge circuit.

Coding and Distribution of Frequencies. The output frequencies of the six oscillators are distributed to keysets, located in the various switchboard positions, and to outgoing senders in the switching equipment. A typical distribution plan is shown in Figure 3. The signaling frequencies have been designated 0, 1, 2, 4, 7, and 10 for the 700-, 900-, 1,100-, 1,300-, 1,500-, and 1,700-cycle frequencies, respectively. Frequencies 0 to 7 are used for the digit codes while frequency 10 in combination with the 2 or 7 frequency is used for special signals. The code which is referred to as an "additive code" is shown in the following table:

Digit	Frequencies in Cycles Per Second	Frequency Designations
1	700+ 900	0+ 1= 1
2	700+1,100	0+ 2= 2
3	900+1,100	1+ 2= 3
4	700+1,300	0+ 4= 4
5	900+1,300	1+ 4= 5
6	1,100+1,300	2+ 4= 6
7	700+1,500	0+ 7= 7
8	900+1,500	1+ 7= 8
9	1,100+1,500	2+ 7= 9
0	1,300+1,500	4+ 7=11
"*KP*"	1,100+1,700	2+10=12
"*ST*"	1,500+1,700	7+10=17

Except for 0, *KP*, and *ST*, the frequency designations add to give a sum equal to the digit being transmitted. This feature of the code assists the maintenance forces when clearing troubles which may occur.

Alarm Features. Each group of oscillators is equipped with various types of alarm features. To guard against failure in the output, sensitive voltage relays are connected across the output circuits of the oscillators in pairs in differential relation. Therefore, if the output voltage of one individual oscillator departs more than 1.5 decibels from the output of its mate, the voltage relay operates and causes the load to be transferred automatically to the other oscillator group, and in addition sounds an alarm. Trouble grounds and power failures also are guarded against, and necessary alarms are given. In addition, an arrangement is provided whereby the transmission of number information, by sender equipment, is halted during the transfer interval, and either transmission is resumed when the transfer is completed or a reorder signal is given to the originating operator.

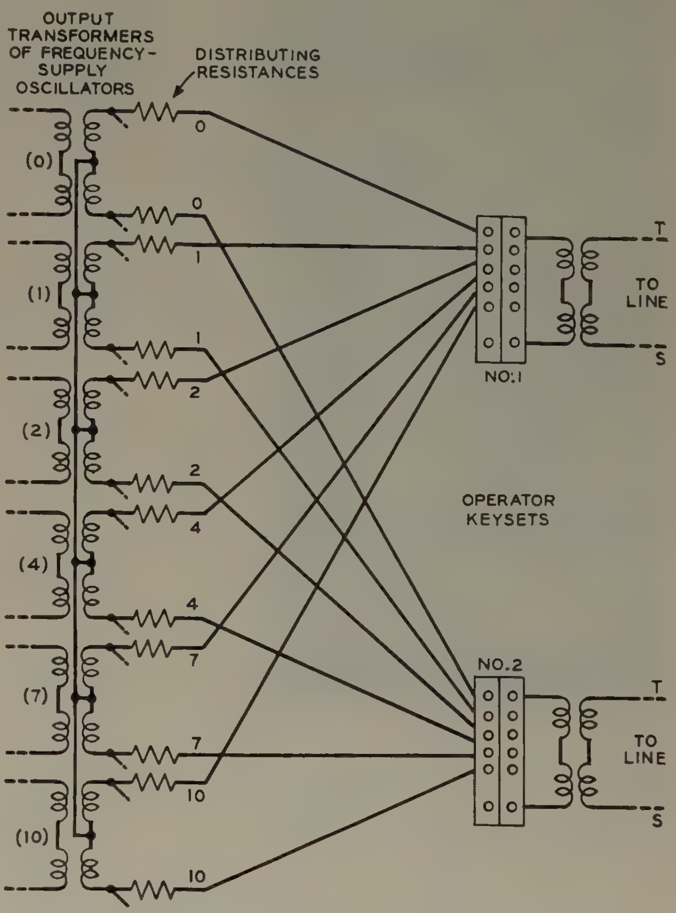

Figure 3. Frequency distribution plan

Figure 4 shows a typical installation of multifrequency supply oscillators, together with alarm relays.

MULTIFREQUENCY SIGNAL RECEIVER

The signal receiver is shown in Figure 5, and a simplified circuit schematic is shown in Figure 6. Starting at the input from the line, there is: a shielded repeating coil, a gain adjusting pad, an impedance controlling resistance, and a volume limiting amplifier. The circuit branches at the output of the limiter; one branch going through the six channel filters, detectors, and relays; and the other going through a high-pass filter, detector, and a low-pass filter to the signal present *SP* relay. The operation of these relays control the registration of the received signals in the sender which is associated with the receiver.

Operation of Receiver by Key Pulsing Signal. When the receiver is first connected to the line, possible false operation by speech prior to the start of pulsing is prevented by means of a slightly different relay arrangement than that shown in Figure 6. With this arrangement, it is necessary that the *KP* signal operate channels 2 and 10, and that all other channels remain unoperated, for a period of at least 55 milliseconds. At the end of this interval, the receiver is changed to the condition shown, and is prepared to accept the digits that are to follow.

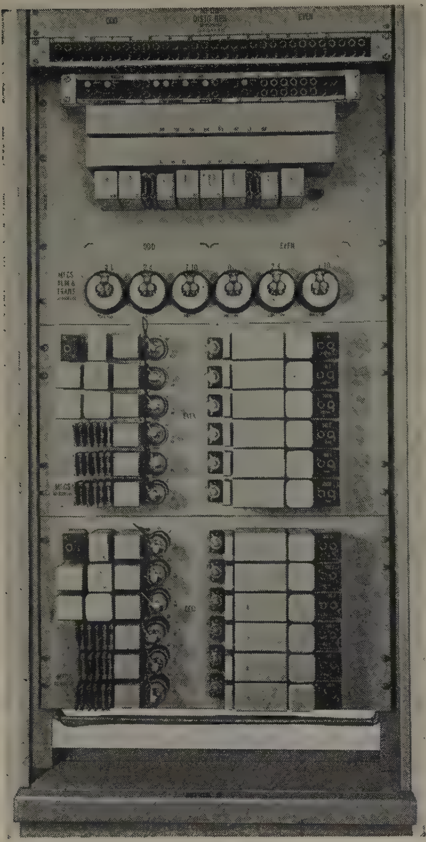

Figure 4. Oscillator and alarm unit

Operation of Receiver by Digit Signals. When the receiver is in the pulsing condition the two signal frequencies applied to the input are amplified or limited depending upon the received signal power. The frequencies are selected then by the two appropriate channel filters and are detected. In the absence of incoming signals, plate current normally flows in the detectors. The presence of a signal biases the tube to reduce this current to a low value, which is more or less independent of the strength of the signal. The channel relays are energized by current from a battery through the *P* windings, and are prevented from operating by the plate current flowing in the *S* windings, which produces a flux which opposes and balances that caused by the current in the *P* winding. Consequently, when plate current is reduced sufficiently the relay will operate. When the back contact of a relay is opened, ground is removed from a resistance and battery to reduce the screen voltage of the tube, which in turn further reduces the plate current, thereby producing a "snap" action to insure rapid and positive operation of the relay armature to the front contact. The reduction in plate current by this means is sufficient to prevent the release of the relay even though the signal is subsequently removed. Thus, the relay is locked in the operate condition until the current in the *P* winding is interrupted by the sender after the registration has been completed.

Both signal frequencies enter the signal present *SP* circuit and pass through a high-pass filter, the purpose of which is to reduce the effects of low-frequency noise, and operate the detector. The low-pass filter in the output of the detector serves to limit the fluctuations in the detector output, which occur at a frequency equal to the difference of the input frequencies, and to delay the operation of the signal present relay. The front contact of this relay controls the operation of the sender to prevent duplicate registration of a digit in case a signal is unduly prolonged, and also applies battery to the operate or *P* windings of the channel relays. This operation is delayed to reduce the effects of transients produced in the channel filters which otherwise would operate falsely other channel relays. The back contact momentarily alters the grid biases of the limiter and signal present detector to reduce effectively the relative sensitivity of the signal channels to avoid false operation by transients. The sensitivity is restored to normal as the capacitor associated with the back contact of the relay becomes charged.

Code Self-Checking Feature. Noise may cause false operation of one or more channels, or more than two frequencies may be received if an operator falsely operates two keys simultaneously.

Since each digit consists of exactly two frequencies, a check can be made that a *bona fide* signal has been received. This is done as follows.

Removal of ground by the back contact of a channel relay permits current to flow through a resistance to the relays *CK1*, *CK2*, *CK3*, and the current through the operate windings of these relays is proportional to the number of channel relays which are operated. The nonoperate bias of the *CK* relays are adjusted so that none will operate with a single channel relay operated, *CK1* and *CK2* will operate with two channel relays operated, and all three will operate when three or more channel relays are operated. These relays control the operation of the sender in such a way that the operation of a single channel relay is ignored, two channel relays operated permits registration of the appropriate digit, and with three operated the sender is informed that the signal is incorrect,

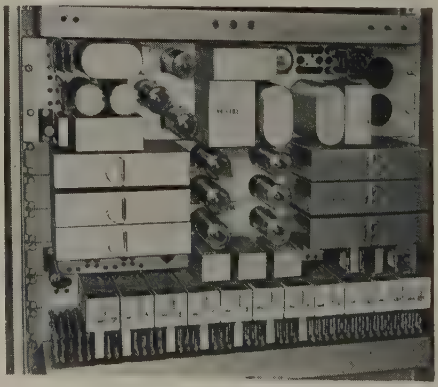

Figure 5. Multifrequency signal receiver unit

whereupon a reorder signal is transmitted to request retransmission of the number.

Transient Protection by Timing. The receiver is required to operate on signals transmitted over lines which differ in attenuation and which have attenuation distortion or "twist." This requires that each channel shall be sufficiently sensitive to operate when the attenuation is a maximum, and not falsely operate on the filter transients when the attenuation is a minimum. To illustrate the significance of this problem and the methods used to satisfy the requirements, we will employ the formulas for the transient response of an ideal band-pass filter given by Guillemin[2] and use only the envelopes of the filter response. When the applied frequency is at the midband frequency of the filter, the envelope of the response to a sine wave of unit amplitube is given by

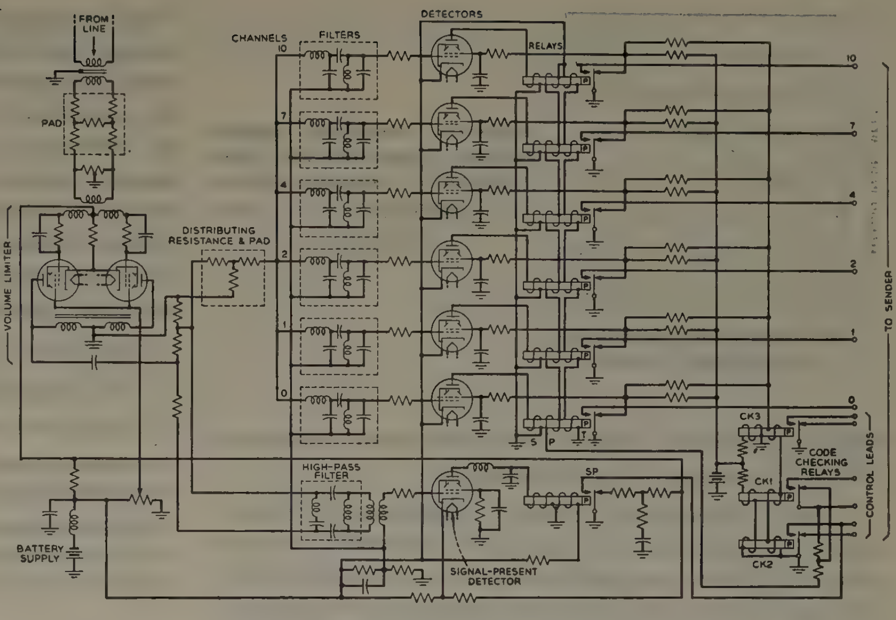

Figure 6. Multifrequency signal receiver schematic

$$E(t)=\frac{1}{2}+\frac{1}{\pi}\,Si\left[\frac{w}{2}\,(t-t_d)\right]$$

where

$$Si(x)=\int_0^x \frac{\sin x}{x}\,dx$$

$$w=2\pi(f_2-f_1)$$

and f_2 and f_1 are the cut-off frequencies of the filter, and t_d is the delay time of the filter. When the applied frequency is outside the pass band of the filter, the envelope of the response is given by

$$e(t)=\frac{1}{\pi}\,\frac{w}{\omega_m}\,\frac{\sqrt{\omega_m^2\cos^2\theta+\omega^2\sin^2\theta}}{\dfrac{\omega^2}{\omega_m^2}-1}\cdot\frac{\sin\dfrac{w}{2}\,(t-t_d)}{\dfrac{w}{2}\,(t-t_d)}$$

$\omega_m = \dfrac{\omega_1+\omega_2}{2}$ is 2π times the midband frequency, and θ is the phase angle of the applied wave. A plot of these equations is shown in Figure 7 for the case of a filter with a pass band 100 cycles wide and a midband frequency of 900 cycles. Since the results obtained with the filters actually used differ materially from those obtained with an ideal filter for times below ten milliseconds, these portions of the curves are not shown. The top curve corresponds to an applied frequency of 900 cycles, and the bottom curve (drawn on an expanded amplitude scale) corresponds to an applied frequency of 700 cycles and a phase which yields the maximum amplitude. t_d was chosen arbitrarily as ten milliseconds. The first maximum of $e(t)$ is approximately 21 decibels below the final value of $E(t)$. Since we may have two frequencies present in channels adjacent to the one under consideration, the transient discrimination is six decibels less or only 15 decibels. Since the wanted signal does not reach its final value until about the time that the unwanted transient reaches its first minimum, it should be possible to increase the discrimination by about nine decibels if operation of the channels is prevented until after the first minimum of the transient has occurred. This is accomplished by delaying the operation of the signal present relay by means of a low-pass filter. To obtain this advantage, the time of occurrence of the minimum response must be the same in all channels. Reference to the foregoing formula shows that this requires the same bandwidth in cycles, and the same delay time for all the channel filters. With these conditions met, approximately

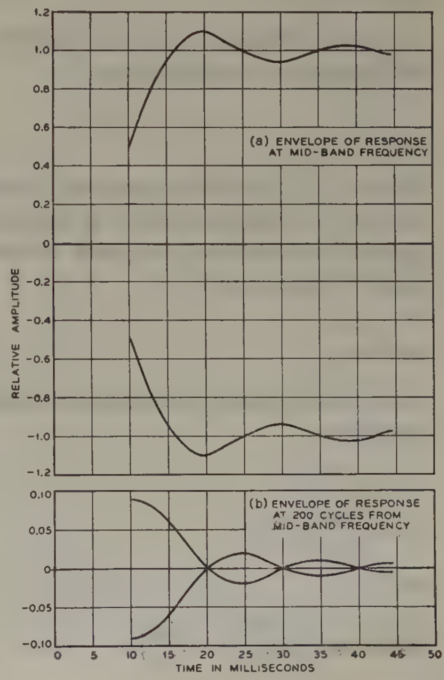

Figure 7. Envelopes of response of band-pass filters to applied sine wave

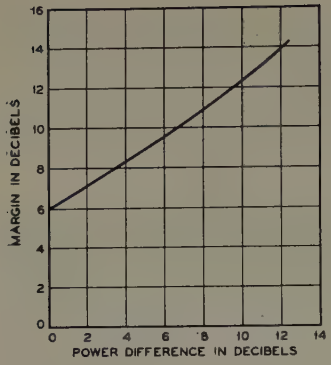

Figure 8. Required margin between "just limit" and "just operate" as a function of the power difference of two frequencies

equal discrimination, transient or steady state, is obtained with equal spacing of signal frequencies.

Transient Protection by Limiting. Additional protection against false operation by transients is secured by the use of a peak limiting amplifier which acts as a linear amplifier for inputs up to a certain definite point called the point of limit, and above this point the output is held constant. With a 2-frequency input to the limiter, it is necessary that the point of limit be at least six decibels above the single frequency input which is just sufficient to operate a channel detector. If there is a difference in amplitude of the two input frequencies, the point of limit must be raised still further. For the case of n applied frequencies, let V_1, $V_2 \ldots V_n$ be the voltage amplitudes at the output of the limiter without limiting, and let V_L be the output voltage when limiting occurs. The point of limit is defined by

$$V_1+V_2+\ldots V_n=V_L$$

If L is the loss in decibels introduced by the limiter above the point of limit, we have

$$(V_1+V_2+\ldots V_n)10^{-\frac{L}{20}}=V_L$$

Without loss of generality, we can assume

$$V_1\leq V_2\leq\ldots\leq V_n$$

To insure operation on the minimum amplitude when limiting occurs, we must have

$$V_1 10^{-\frac{L}{20}}\geq V_0$$

Where V_0 is the voltage required to just operate a channel detector. M is the margin in decibels between the "just operate" voltage and the point of limit, measured with a single frequency or

$$V_0 10^{\frac{M}{20}}=V_L$$

From the foregoing equations we obtain as a condition for operation

$$\frac{V_1 10^{\frac{M}{20}}}{V_1+V_2+\ldots V_n}\geq 1$$

or

$$M\geq 20\log_{10}\left(1+\frac{V_2}{V_1}+\ldots\frac{V_n}{V_1}\right)$$

Thus, the margin between "just limit" and "just operate" is determined by the number of frequencies and is a function of the ratios of the larger voltages to the smallest one. For the case of $n=2$, M is shown in Figure 8 as a function of the difference in decibels of the two voltages. With a nominal margin of 12 decibels, the maximum difference between two voltages is about ten decibels.

When allowance is made for variations in components of the frequency sources and the receivers, the following operating characteristics are obtained:

1. Digit and "*ST*" signal duration, 27 milliseconds or greater.
2. "*KP*" signal duration, 55 milliseconds or greater.
3. Interval between signals, 20 milliseconds or greater.
4. Maximum receiver input power, two decibels above one milliwatt at each signal frequency.
5. Minimum receiver input power, 27 decibels below one milliwatt at each signal frequency, provided the difference in power between the two frequencies making up the signal does not exceed 6.5 decibels.

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New Mercury-Unit Power Plant

The first postwar mercury-unit power-plant equipment has been placed in operation in the South Meadow Station of the Hartford (Conn.) Electric Company. Designed by the General Electric Company, the equipment uses mercury vapor at a pressure and temperature of 113 pounds per square inch gauge and 945 degrees Fahrenheit to drive a mercury turbine at 720 rpm. The unit generates 15,000 kw, at the same time supplying about 200,000 pounds of steam per hour at 400 pounds per square inch gauge and 700 degrees Fahrenheit to drive existing steam turbines.

Hartford's system combines the mercury-vapor cycle and the steam cycle into a binary system for producing power from fuel with a greater thermal economy than is possible using steam alone. The mercury-steam cycle utilizes a mercury boiler, in which liquid mercury is vaporized at comparatively low pressure; a mercury turbine, powered by the vaporized mercury; a generator, driven by the turbine; a mercury condensor; a boiler, where the heat given up by the condensing mercury is used to convert water into steam, which drives the steam turbines.

The new installation replaces a smaller unit that has been in service 20 years. The old unit was the first large mercury unit installed in the United States. It was rated at 10,000 kw. Both mercury turbines have been "topping applications." A topping application is one in which a mercury-unit power plant is superimposed on existing steam turbines to raise the temperature range through which the power cycle operates. General Electric engineers expect to install more power-generating equipment of this type in the future.

The Mechanism of the Supersonic Bias

ANGELO MONTANI

THE NONLINEAR relationship between exciting current and the flux generated in magnetic alloys is a source of continuous difficulties in the design of magnetic devices and circuits. Magnetic recording is not an exception to the rule. The audio signals are recorded as elements of residual magnetism stored along the length of the magnetic wire or tape.

The residual magnetism curve, or retentivity curve, as shown in the upper part of Figure 1, presents a definite inflection at the origin. The retained, or stored, flux is reckoned along the B_r axis and expressed in gauss. On the H axis, the magnetomotive-force gradient in oersteds is represented.

The inflection at the origin of the retentivity curve does not allow the faithful recording of a sine wave on a completely demagnetized medium. The two branches of the curve, symmetric with respect to the origin, reflect the physical fact that the gradient H of magnetomotive force can assume opposite directions because of the opposite phases of the alternating currents circulating in the exciting electromagnet. In the present instance, the electromagnet is the recording head.

One way of getting around the distortion caused by the retentivity curve has been to superimpose on the audio frequency to be recorded, a supersonic freuqency which, by its very nature, is inaudible. The reasons as to why the distortion is reduced to an acceptable level by this procedure generally is misunderstood. With the aid of Figures 1 and 2, the supersonic-bias mechanism can be mastered clearly, at least, qualitatively, using an analogy to the operation of the push-pull class-B amplifier.

Figure 2 shows the virtual straight-line transfer curve resulting from the algebraic summation of the point-by-point values of the real transconductance curves of two tubes. The virtual transfer line will be straight only under the condition that the two real curves can be expressed closely with a second-degree equation. This condition generally is fulfilled in practice. The input audio signal is applied to both transconductance curves at the same time. Each curve introduces a large amount of second-harmonic distortion. The resulting output signal is not distorted because the distortion is washed out in each alternation. Whereas, in the case of the amplifier, the two curves are separated, it is a physical impossibility to split the retentivity curve at the origin. Actually, that is tantamount to a magnet possessing but one pole. Consequently, the audio signal is split into two and applied to the upper and lower branch of the retentivity curve. As shown in Figure 1, the supersonic frequency superimposed on the audio frequency provides two identical and phased profiles displaced by twice the amplitude of the supersonic frequency itself.

By proportioning the supersonic amplitude, the two resulting audio-frequency profiles can be positioned on those arcs of the retentivity curve which can be approximated most closely with an equation of the second degree. Then the resultant output (which is the algebraic sum of both distorted waves) will be acceptably free from distortion.

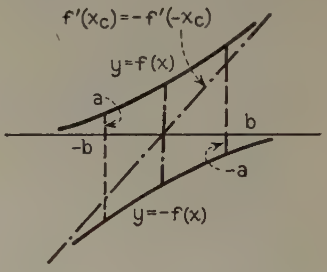

Figure 2. Virtual transfer line

A critical inspection of Figures 1 and 2 will yield an intuitive insight of the inherent similarity of the two procedures. In the case of the class-B amplifier, the curves are already split at the origin and the input audio signal is applied simultaneously to both. In magnetic recording, the two branches of the retentivity curve cannot be split, and consequently, the input audio signal itself is split into two identical ones by means of the supersonic frequency. Both identical audio signal profiles then are applied simultaneously to both branches of the retentivity curve.

It follows that, from the viewpoint of fidelity, the best recording medium is the one having the most extended portions of the retentivity curve that can be approximated with a second-degree equation.

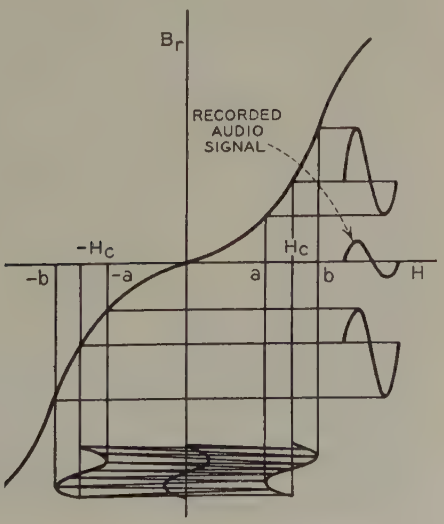

Figure 1. Supersonic shifting of the audio signal

Digest of paper **49-54,** "The Mechanism of the Supersonic Bias," recommended by the AIEE communications committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Not scheduled for publication in AIEE *TRANSACTIONS*.

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Stray Load Losses Measured in D-C Motors

AN AIEE COMMITTEE REPORT

STANDARD open general-purpose d-c motors, rated 0.5-, 5-, 10-, 25-, and 50-horsepower, 40 degrees centigrade, 1,750 rpm, have been tested for stray load losses by five manufacturers on an exchange program at the request of the AIEE committee on rotating machinery. The purpose has been twofold: firstly, to determine how well the actual stray load loss agrees with the standard practice of taking this loss as one per cent of the output power; secondly to seek a more accurate determination of the loss in terms of the load current and the voltage, speed, and size of the machine.

Stray load loss was measured on each motor for 27 load conditions covering three values of load current, three values of excitation, and three values of speed. It was found from the average of all test data that for these motors' stray load loss is three per cent of the output power. This holds true at the average output of all the test conditions but was found to vary with load conditions. For example, at the rated full-load output of the motors it averaged two per cent.

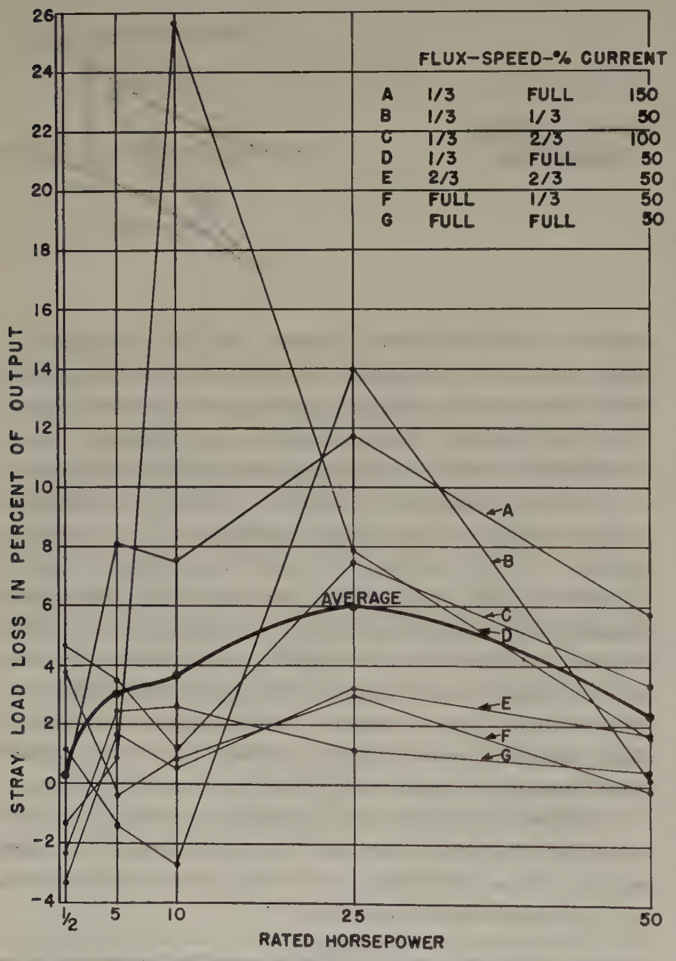

Figure 1. Loss versus rated horsepower

Points are averages of two tests for the 5-, 10-, 25-, and 50-horsepower motors and one test for the 1/2-horsepower motor

The average results of the tests indicated the following relations for stray load loss:

$$\frac{W}{hp}=0.02\frac{n}{n_r}\left(\frac{i}{i_r}\right)^{3/2}\frac{hp_r}{hp}$$

$$\frac{W}{hp}=0.02\frac{\phi_r}{\phi}\sqrt{\frac{i}{i_r}}$$

where W is the stray load loss in horsepower at any operating condition, n is the speed of operation, n_r is the rated base speed, i is the load current, i_r is the rated full-load current, hp_r is the rated full-load horsepower, hp is the output load, ϕ_r is exciting field flux at rated full load, and ϕ is the exciting field flux at the output load.

Therefore, the tests suggest that a standard definition for stray load loss might be of this form, provided proper coefficient and exponential constants are determined for the several groups of machines divided according to size and type (for example, with pole face windings or not). Until these constants can be determined by future extension of the work the committee recommends that the present flat allowance of one per cent be maintained.

The motors were tested by measuring the losses and output power by dynamometer, measuring the electric input power by meters, subtracting the output power from the input, and subtracting measured losses from the difference.

The heavy line in Figure 1 represents the average result of 54 tests on each motor, covering load outputs from four per cent of the rating to 150 per cent of the rating. The light lines in this illustration show the wide variation of load loss as a percentage of output as measured in these tests.

Regardless of the method used, large differences are to be expected between results of individual tests, because the brush loss due to friction and contact drop is subject to wide variations and is commensurate in size with the stray load loss itself. It has been suggested that the brush rigging be supported on bearings so that the friction can be measured continuously and that the brush contact voltage be read continuously through the use of an insulated brush. If this is done, a departure is made from the definition of stray load loss which includes the vagaries of brush friction and contact loss as a part of stray loss. The committee believes that a great mass of test data is essential to find the general truth.

Digest of paper **49-63**, "Stray Load Losses Measured in D-C Motors," recommended by the AIEE rotating machinery committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

Personnel of the AIEE subcommittee on d-c machines: T. M. Linville (*chairman*), Mrs. B. O. Buckland, W. E. Clancy, F. A. Compton, Jr., Lanier Greer, J. L. Hamilton, C. B. Hathaway, V. P. Hessler, V. B. Honsinger, W. R. Hough, P. Lebenbaum, C. Lynn, L. G. Opel, D. Ramadanoff, J. F. Sellers.

Television Receiving Systems

C. M. SINNETT

With the development of large-scale manufacture of popular-priced television receiving sets in response to greatly increased demand, television now has reached the status of a full-fledged industry. The next major development probably will be color television, however black-and-white television still is undergoing rapid changes which should result eventually in lower-priced receivers with clearer pictures and greater contrast.

THE GROWTH of television during the past year has exceeded the most optimistic postwar predictions. Many factors have contributed, but probably the most important ones were the televising of such events as the World Series baseball games, the Army–Navy football game, the heavyweight fights, and the political conventions, which created a public desire for receivers, and the development, design, and manufacture of large quantities of popular-priced receiving instruments to satisfy this desire. Thus television has turned the corner and bids fair to become an industry surpassing the automobile industry. Most of the immediate problems have been solved, but new ones are appearing constantly which will test the mettle of the engineering fraternity before complete solutions are found.

ANTENNA CONSIDERATIONS

Television signals, by virtue of their location in the frequency spectrum, are limited normally to line-of-sight transmission. Under unusual atmospheric conditions, however, such signals may be received at locations hundreds of miles from the transmitter. At present the first five television channels are located between 50 and 88 megacycles and the remaining seven channels between 174 and 216 megacycles. Each television channel is 6 megacycles wide with the picture and sound radio-frequency carriers separated by 4.5 megacycles. Amplitude modulation with one side band suppressed is employed for picture transmission. Frequency modulation to a maximum deviation of ±25 kc is used for sound. The effective radiated power from television transmitters, for antenna heights greater than 500 feet, is so regulated as to give the same coverage as would be obtained with 50 kw at 500 feet. Thus, if the antenna height is only slightly greater than 500 feet, the effective radiated power can be nearly 50 kw, but must be decreased as the antenna height is increased.

The foregoing information indicates broadly some of the factors which must be considered in the design of a television receiving antenna such as broad frequency band coverage, controllable directivity, good signal pickup, ease of installation, and low cost. No single antenna available at present fully meets all of these requirements. Fortunately, however, with the majority of television transmitting antennas located near the center of a city, it is possible to provide satisfactory reception with comparatively simple receiving antenna structures. These are the half-wave dipole or the half-wave dipole plus reflector used as all-channel antennas. Special requirements may dictate the use of a half-wave folded dipole and reflector for the lower frequency channels and a smaller folded dipole and reflector for the higher frequency channels. Under some conditions the foregoing combinations may be necessary to provide satisfactory signal pickup in outlying areas. The dipole and reflector has been found to meet the desired requirements in a high percentage of the installations to date.

Figure 1 shows the response characteristics of dipoles and reflectors cut for various resonant frequencies. In each case the reflector is spaced approximately 0.2 wave length from the antenna with the antenna directed toward the transmitter. It will be noted that an assembly resonant to the lower frequencies will provide essentially the same signal pickup at the higher frequencies as can be obtained from similar assemblies cut for the latter frequencies. The converse is not true, however, and consequently such antenna systems are tuned to the low-frequency television channel. The reflector contributes about 50 per cent additional signal pickup to that obtained from a simple dipole. Folded dipoles, while giving greater signal pickup at the resonant frequency, tend to be more selective and are used only when local conditions dictate the need for

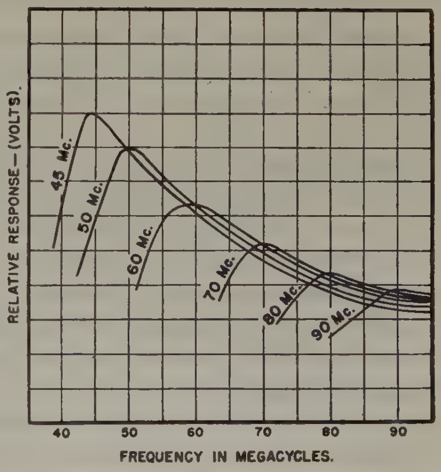

Figure 1. Response of dipoles and reflectors cut for various resonant frequencies (antennas used with 300-ohm line)

Full text of paper **48-278,** "Television Receiving Systems," recommended by the AIEE communication committee and approved by the AIEE technical program committee for presentation at the AIEE Midwest general meeting, Milwaukee, Wis., October 18–22, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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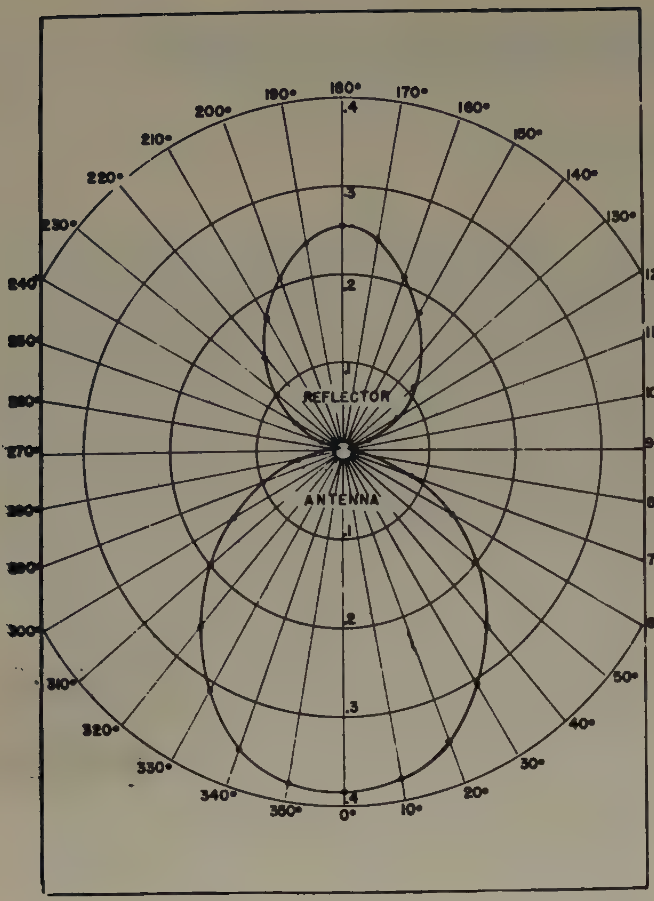

Figure 2. Polar characteristic of dipole and reflector at 44 megacycles

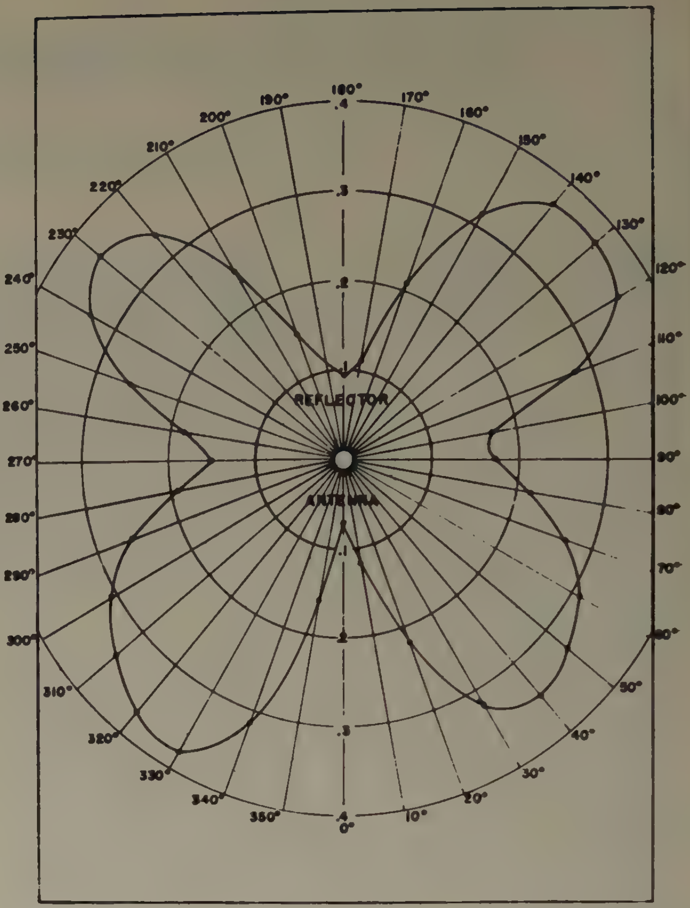

Figure 3. Polar characteristic of dipole and reflector at 174 megacycles

greater signal pickup than can be obtained from dipole-reflector assemblies. A single folded dipole and reflector assembly providing the increased pickup will serve for the higher television channels, as the total frequency band coverage required of the antenna represents only 20–25 per cent of the carrier frequency employed.

A directivity pattern of a receiving antenna assumes importance when its location is such that reflected signals or man-made static are problems. A high front-to-back ratio, obtained by stacked arrays, may be required under certain circumstances. This is the exception rather than the rule, however, as indicated by the almost universal use of the dipole and reflector assembly.

Figure 2 shows the polar characteristics of the dipole and reflector at 44 megacycles. A front-to-back ratio of nearly two-to-one is obtained with null areas along the axis of the dipole.

Figure 3 shows the polar characteristics of the same antenna assembly at 174 megacycles. The two lobe pattern of Figure 1 has become a sort of four leaf clover pattern with lobes existing at approximately 38 degrees from those at the lower frequencies. Essentially the same pattern is obtained at 216 megacycles. In many instances, this change in pattern between the two television bands works to the advantage of the viewer since a compromise orientation can be made between low- and high-frequency stations providing optimum performance on both. In other instances two antenna assemblies, together with the use of adequate phasing or switching means, may prove to be necessary.

An antenna which will pick up the signal is only part of the story. On the average the antenna is located some 70 feet from the receiver and requires some form of transmission line between the two. Prior to World War II a transmission line representing the best compromise between cost and performance had losses of the order of 5 decibels per 100 feet at 50 megacycles and 12 decibels per 100 feet at 200 megacycles. Under some conditions, this meant that an increase in antenna elevation could be nullified by the losses of the transmission line extension. During the war a new dielectric, known as polyethylene,[1–4] was developed for use at ultrahigh frequencies. This dielectric, while expensive, had excellent electrical and mechanical properties. A parallel wire transmission line, using polyethylene as a supporting medium, was developed for use with television antennas and receivers. This line has a characteristic impedance of approximately 300 ohms, is relatively low priced, and has extremely low losses. Figure 4 shows these latter characteristics over the range 20 to 200 megacycles. Even at the highest television frequency, 216 megacycles, the loss is less than 2 decibels per 100 feet. Many other uses have been found for this line such as matching stubs, folded dipole antennas, and impedance transformers.

THE TELEVISION SIGNAL

The composite television signal contains all the information necessary to synchronize and produce a picture at the receiver. It contains horizontal and vertical synchronizing signals, return beam blanking, and video or picture information including tonal gradations from black to white. The horizontal pulse rate is 15,750 cycles per second and the vertical pulse rate is 60 cycles per second.

Figure 5 shows this composite signal for several horizontal lines and two vertical fields. The television picture employs interlacing scanning 525 lines, 60 fields, 30 frames per second. Observation of the figure indicates the relative heights of synchronizing, blanking, black level, video modulation to white level, and zero carrier. This signal, after detection in the receiver, is separated and fed to the video amplifier and the horizontal and vertical synchronizing circuits.

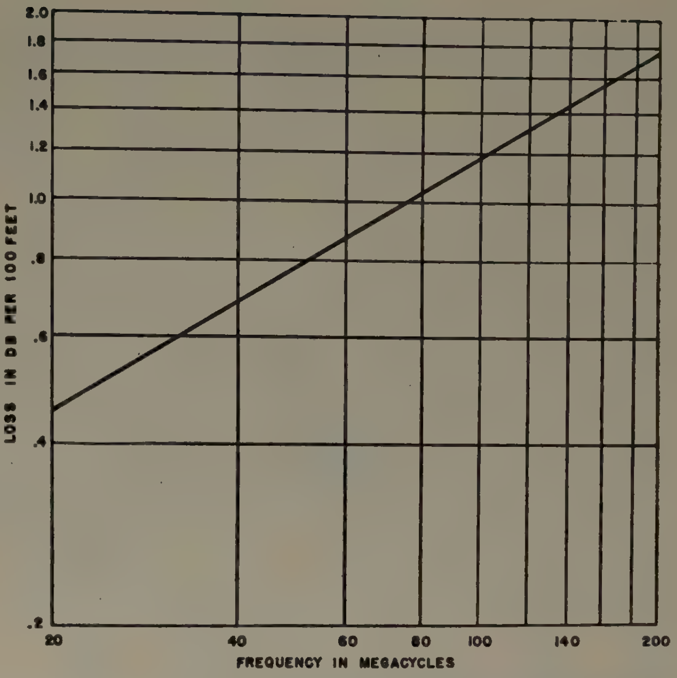

Figure 4. Loss characteristics of RCA "bright picture" television transmission line

DIRECT VIEWING AND PROJECTION RECEIVERS

Figure 6 is a block diagram of a conventional television receiver indicating the various functions. The radio-frequency signals, video and sound, picked up by the antenna are fed to the radio-frequency unit. This unit, which can be tuned by suitable means to any one of the 12 television channels, converts the various high-frequency video and sound radio-frequency signals to fixed intermediate frequencies of 21.25 megacycles for sound and 25.75 megacycles for video. At the output of the radio-frequency unit these two intermediate frequencies, including the necessary side bands, are fed to the sound and video intermediate-frequency amplifiers. The sound channel provides the necessary intermediate-frequency gain properly to operate conventional frequency-modulation detector circuits. Audio amplification follows and is fed to a dynamic-type loud-speaker. The video radio-frequency amplifier consists, in this case, of stagger-tuned stages to provide the necessary amplification and band width and feeds a conventional amplitude detector. From the detector the video signal is applied to a video amplifier consisting of two stages. This amplifier is a-c coupled and introduces an a-c axis about which the video signal tends to swing unless some form of correction is applied.

This correction takes the form of a d-c restorer which corrects the picture tube grid bias to suit the various scenes. In addition, the d-c restorer circuit provides partially separated synchronizing signals which are applied to the input of the synchronizing signal chain. Here, synchronizing is separated completely from picture and in turn directed to the vertical pulse and saw-tooth generator and to the horizontal saw-tooth generator and "flywheel" circuit. The vertical saw-tooth is applied to the vertical deflection coils comprising one portion of the deflection yoke surrounding the neck of the picture tube. The flywheel circuit, in addition to providing a pulse for proper operation of the horizontal discharge tube, insures complete horizontal synchronization of the picture under practically all conditions met in the field. The horizontal discharge or output tube provides the necessary deflection current to the horizontal windings of the deflection yoke and in addition, through a step-up transformer provides approximately 9,000 volts, after rectification, to the picture tube. A conventional low-voltage power supply completes the receiver.

For all its apparent complexity a television receiver is comparatively easy to operate. Seven major controls are provided on the front panel comprising station selection, fine tuning for sound, horizontal synchronizing, vertical synchronizing, picture contrast, picture background, and

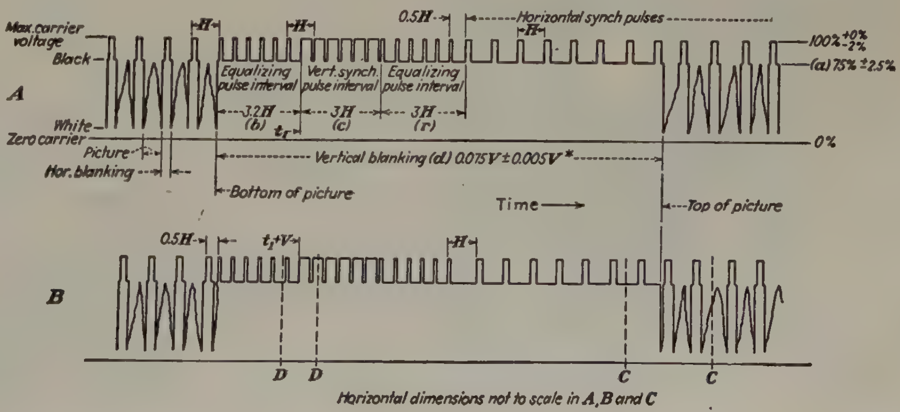

Figure 5. Television synchronizing wave form for amplitude modulation

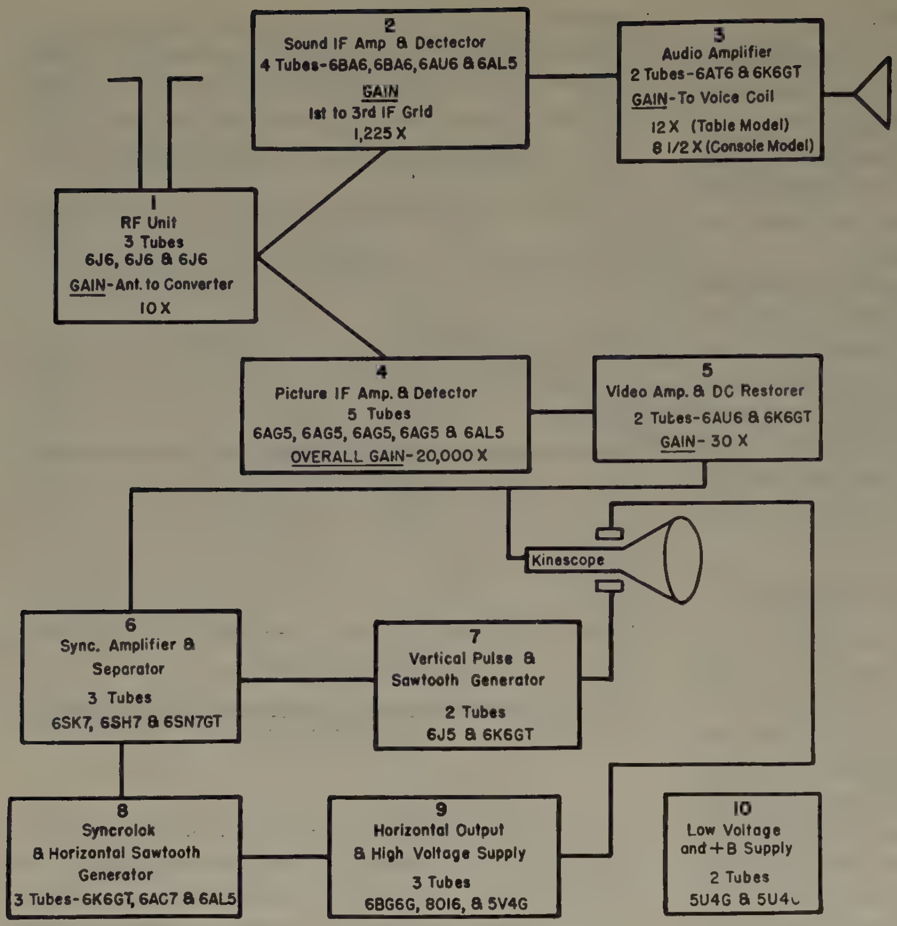

Figure 6. Block diagram of a conventional television receiver

an audio volume control. As the art progresses it may become feasible to eliminate front panel controls of horizontal and vertical synchronizing, fine tuning, and picture contrast. At the present time several other screw driver adjustments are provided on the chassis for horizontal size, vertical size, horizontal and vertical centering, linearity, and focus. When properly adjusted at the time the receiver is installed readjustment is seldom required.

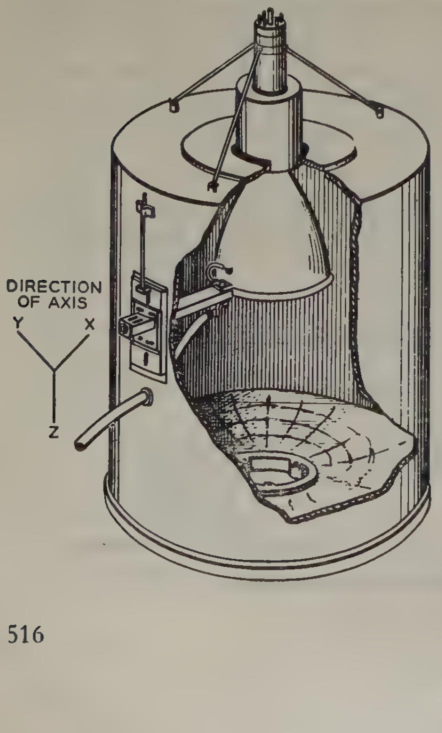

Figure 7. Cutaway view of an optical barrel in the Schmidt optical system

While the mass market for television receivers probably will involve the lower-priced table models, there is a relatively large demand for pictures of larger size than can be produced economically by means of direct viewing picture tubes. To meet this demand, various projection systems have been proposed. Two of these have assumed some prominence; the refractive or conventional lens system and the reflective or Schmidt system. Neither of these fully satisfies the requirements. The refractive system, while more flexible in adapting picture size to varying viewing conditions and requiring less cabinet space, is not as efficient as the Schmidt system. Since light output is expensive to obtain in a television receiver, the trend has been toward the more efficient Schmidt system.

Figure 7 shows a cutaway view of an optical barrel such as is used in the Schmidt optical system. Normally, a 4- or 5-inch diameter picture tube, operating at 27,000 volts second anode, is used. The surface of the face of the picture tube has a curvature which is designed to work with the spherical mirror and aspherical lens of the reflective optical system. The tube faces the mirror in the bottom of the optical barrel. Reflected light rays from the spherical mirror pass through an aspherical lens and are brought to sharp focus on the viewing screen. By proper design it is possible to construct such an optical system with a magnification of six, a "throw" of roughly 36 inches, and obtain resolution of over 1,500 lines in the corners of the picture. The effective aperture of such a system is of the order of *f* 0.8.

For use in the home, it is desirable that the viewing screen, used for television projection, possess certain optical characteristics. A picture seldom, if ever, will be viewed from the extreme sides because of image distortion; consequently, the screen is provided with directional characteristics which conserve the available light and result in a gain in light output over that obtained with the ordinary diffusing screen. Experience has indicated that such a screen, possessing a horizontal included angle of roughly 60 degrees and a vertical included angle of 15–20 degrees, will meet practically all the requirements. In a transmissive screen the horizontal and vertical directivities are obtained by means of vertical ribs on the front surface of the screen and a Fresnel lens on the back, the screen having been moulded from clear plastic with a diffusing interlayer. In a reflective screen a metal reflector is provided with microscopic vertical lines plus a light spray of diffusing material to obtain horizontal directivity and is then slightly

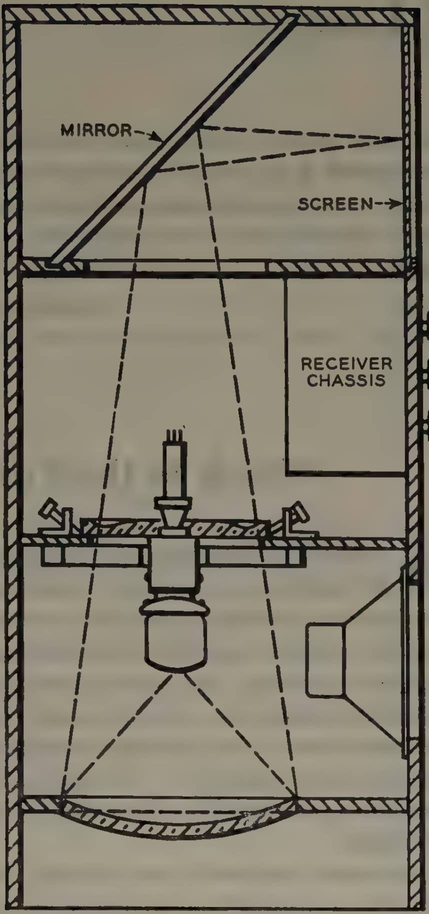

Figure 8. Arrangement of optical system for a home television receiver employing reflective optical principles

This design gives a large-screen picture with a console cabinet no deeper than that of an ordinary home radio receiver

curved about a horizontal axis to provide the desired vertical directivity. With either screen a gain in light output five to seven times that of the ordinary diffusing screen is obtained. Both are in use and provide a 20- by 15-inch picture of adequate brightness and resolution.

Figures 8 and 9 show the layout of the Schmidt system using a transmissive screen and a reflective screen, respectively.

The Schmidt optical system has been employed for theater television projection on a screen 24 feet by 18 feet. Figure 10 shows such a system using a spherical mirror 42 inches in diameter and a picture tube which may be either 12 or 15 inches in diameter. This constitutes the largest Schmidt-type optical projection system used today.

In conclusion it should be stated that the foregoing discussion of television receivers is of necessity very brief. Many items of interest and importance have been omitted for the sake of brevity. It is sufficient to say that television is undergoing rapid changes which will result eventually in lower priced receivers having clearer pictures and greater contrast. With all that is being learned about black-and-white television and the application of this knowledge, plus the expenditure of large amounts of time and money to color television, its eventual introduction is assured. However, color television will introduce many new problems to be solved in the laboratory and substantiated by field tests before being offered to the public.

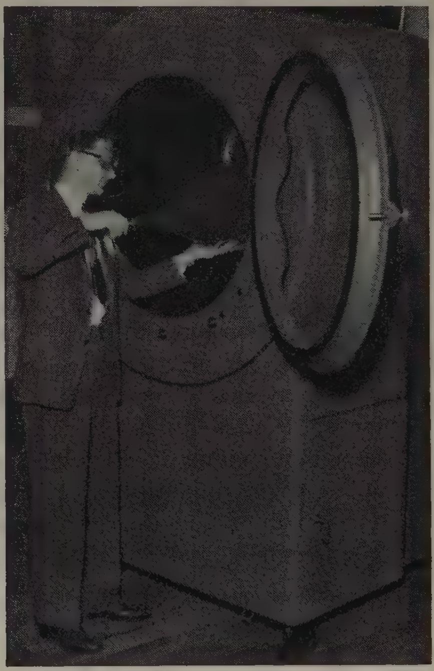

Figure 10. The Schmidt optical system using a 42-inch spherical mirror and a 12- or 15-inch picture tube

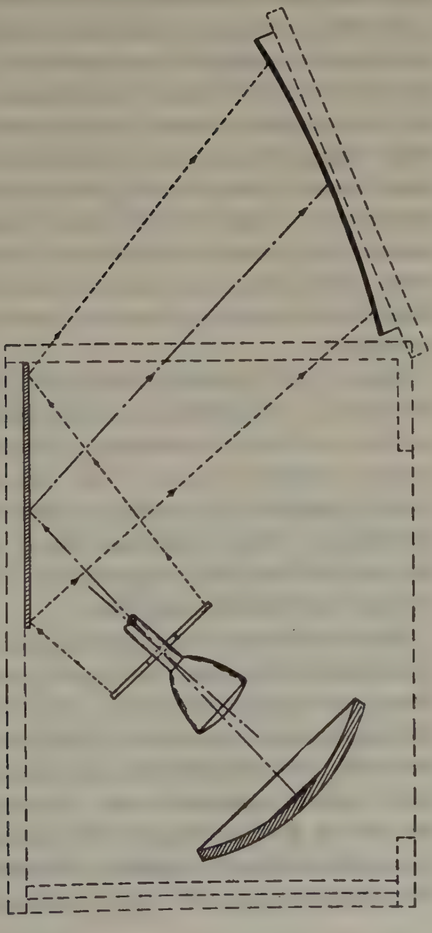

Figure 9. The Schmidt optical system using a reflective screen

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Electrical Essays

A Nonlinear Problem

The ordinary rectifier circuit is used in many applications. Single-phase excitation is the most common for low power requirements. In order to increase the ripple frequency and thus simplify the filter design, it is necessary to introduce some phase inverter device, usually a transformer with a center tapped secondary, and full-wave rectification is obtained. Under such condition of operation the average currents through each half of the secondary are equal and their directions are such as to produce a net zero average magnetomotive force on the core of the transformer. As the magnetomotive force due to the primary current must oppose that due to the secondary currents, and as the net secondary magnetomotive force has zero average, the primary current will have zero average.

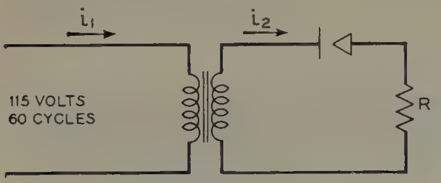

Figure 1

In many applications requiring high constant potential a single rectifier is used in the secondary circuit of a stepup transformer. The secondary current, and therefore the magnetomotive force due to it, certainly will have an average value different from zero. Does the primary current also have an average value differing from zero?

In order to answer this question consider a half-wave rectifier without a filter, Figure 1, and assume the coefficient of coupling of the transformer is practically unity and that under no condition does the core saturate. The secondary current i_2 then has, for all practical purposes, the wave shape shown in Figure 2*A* and the magnetomotive force due to it will be of the same shape. The magnetomotive force due to the primary current (neglecting exciting current) must be the negative of the secondary magnetomotive force and therefore takes the shape shown in Figure 2*B*. Because i_2 is zero during the period from t_2 to t_3, i_1 must be zero also during the same time, and it follows that the primary current has an average value different from zero.

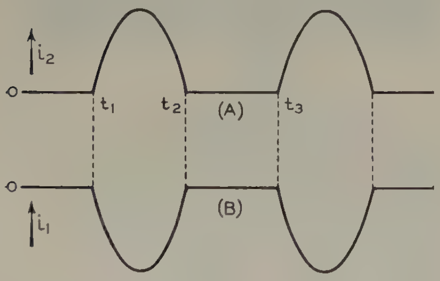

Figure 2

If a d'Arsonoval ammeter were placed in the primary line, the average value would be indicated. When this is attempted in an actual experiment there is no measurable value, even with core saturation, although the theory outlined indicates that there should be an appreciable average primary current. What is wrong?

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Which Is the Primary?

A TRANSFORMER was constructed very accurately in the form of a toroid. The doughnut-shaped core was wound uniformly with the toroidal primary winding. Then the toroidal secondary winding was wound outside the primary winding. Of course there was a slight blemish upon the uniformity of the toroidal quality, because the terminal leads of the primary needed to pass between the turns of the secondary. The effect of this asymmetry is negligible however for the problem to be presented in this essay.

In many textbooks, the primary leakage reactance is defined as arising from that flux which links the primary winding and which does not link the secondary. Similarly, the secondary leakage reactance is said to result from that flux which links the secondary and does not link the primary.

For this particular transformer, the magnetic field has a very simple geometric configuration. The lines of magnetic force are all circles with centers on the straight line axis of circular symmetry of the toroid. All the lines of force which link any one turn of the primary link all the other turns of the primary and also all the turns of the secondary. A line of force which passes through a point outside the primary but inside the secondary links all the turns of the secondary, but links no turn of the primary. Outside the secondary, however, there are no lines of magnetic force.

Since all the flux which links the primary also links the secondary, so that there is no flux which links the primary and does not link the secondary, it follows that the primary leakage reactance is zero. On the other hand there are lines of magnetic force which lie between the primary and secondary. There is therefore flux which links the secondary and does not link the primary. The secondary leakage reactance is therefore not zero.

The transformer was placed inside a case or box (carefully painted black) and connected to two sets of terminals. The case was locked securely. All information concerning the transformer subsequently was lost, in the 1936 flood, except that the transformer was so designed as to make primary leakage reactance zero. An engineer now is given the task of determining by 60-cycle measurements at the terminals which is the winding with zero leakage reactance. How shall he proceed? Surely with such a large difference in leakage reactance there must be some simple way of determining which is the primary and which the secondary.

J. SLEPIAN (F '27)

(Associate director, Westinghouse Research Laboratories, East Pittsburgh, Pa.)

Answer to Previous Essay

The following is the author's answer to his previously published essay, "Turn Ratio of Transformers" (*EE, May '49, p 449*).

The number of physical turns put into the coils of the transformer is certainly important to the transformer designer and coil winder, but the turn ratio itself appears only as a somewhat nebulous and uncertain constant in the electrical performance of the transformer.

For simplicity, let us first in our discussion neglect any saturation or other effects in the iron which would introduce harmonic currents or voltages. In other words, let us suppose that the terminal voltages and currents are related linearly. Also, let us suppose that eddy currents are negligibly present so that in equations 1 M may be taken as real. Then all that our measurements can give us are the coefficients in these equations.

$$E_1=(r_1+j\omega L_1)I_1+j\omega MI_2 \qquad (1)$$
$$E_2=j\omega MI_1+(r_2+j\omega L_2)I_2$$

Here, the E's and I's are complex numbers, representing in the usual way the sinusoidal voltages and currents. r_1, L_1, r_2, and L_2 are real and positive. M, as stated previously, is real; and we choose the positive direction for I_2 so as to make M positive. Furthermore, we always have $M^2<L_1L_2$. Whatever electrical significance the turn ratio $r=n_1/n_2$ may have, it must be expressible in terms of the coefficients of equations 1.

Now, $r=n_1/n_2$ appears in the theory of the transformer as more usually taught through the following fairy story. There is a good fairy flux, Φ, which graciously and fairly links each and every turn of each primary and each secondary coil exactly 1.000000 times. Thus each turn has induced in it a voltage

$$E_t=k_1j\omega\Phi \qquad (2)$$

where k_1 is the proper numeric. Hence we have induced in the primary and secondary coils the voltages

$$E_1\text{ ind}=n_1k_1j\omega\Phi \qquad (3)$$
$$E_2\text{ ind}=n_2k_1j\omega\Phi$$

However, these are not the terminal voltages. Besides the r_1I_1 and r_2I_2 drops which cannot be helped, there are certain bad fairy leakage fluxes. Bad fairy primary leakage flux links only the primary turns, skillfully dodging the secondary turns, and remains always proportional to the primary current, and indifferent to the secondary current. It therefore introduces a reactive drop in the primary, jX_1I_1.

Similarly, a secondary leakage flux introduces a secondary reactive drop, jX_2I_2. Our fairy story then becomes

$$E_1=(r_1+jX_1)I_1+n_1k_1j\omega\Phi \qquad (4)$$
$$E_2=(r_2+jX_2)I_2+n_2k_1j\omega\Phi$$

Now, what is the relation of Φ to the currents in the primary and secondary. Naturally, since Φ treats all turns alike, Φ will be proportional to $n_1I_1+n_2I_2$, so that

$$\Phi=k_2(n_1I_1+n_2I_2) \qquad (5)$$

where k_2 is the appropriate numeric.

Substituting equation 5 in equation 4 we get

$$E_1=(r_1+j[X_1+k_1k_2n_1^2\omega])I_1+(jk_1k\,n_1n_2\omega)I_2 \qquad (6)$$
$$E_2=(jk_1k\,n_1n_2\omega)I_1+(r_2+j[X_2+k_1k_2n_2^2\omega])I_2$$

Comparing these equations with equation 1 which contains all that experiment can give, we get, to determine our electrical turn-ratio and the primary and secondary leakage reactances,

$$r_1+j\omega L_1=r_1+j[X_1+k_1k_2n_1^2\omega]$$
$$r_2+j\omega L_2=r_2+j[X_2+k_1k_2n_2^2\omega] \qquad (7)$$
$$j\omega M=j\omega k_1k_2n_1n_2$$
$$r=n_1/n_2$$

These are not enough equations, but unfortunately they are all we have.

Eliminating as far as we can we get

$$X_1=\omega(L_1-Mr) \qquad (8)$$
$$X_2=\omega(L_2-M/r)$$

Hence, so far as the electrical performance is concerned, we may take the electrical turn ratio to be anything we please ignoring completely anything the manufacturer tells us. He may be trying to deceive us. If we take X_1 and X_2 by equations 8, then equations 6 and fairy story, equations 4, will be satisfied.

However, we may have a quite unfounded prejudice against reactances X_1 and X_2 being negative or zero even though they are such ill-defined fairy creatures. In that case we cannot be completely free in our choice of r. W must have (L_1-Mr) and (L_2-M/r) each greater than zero. This requires that

$$L_1/M>r>M/L_2 \qquad (9)$$

Since always

$$L_1L_2>M^2 \qquad (10)$$

and therefore

$$L_1/M>M/L_2 \qquad (11)$$

there always will be a range for r which will make both X_1 and X_2 positive.

Thus, if we have no prejudice against negative leakage reactance, we may make r anything we please, and appropriate main and leakage fluxes can be found. If, however, we insist that leakage fluxes be positive, then r is restricted to a range which will be narrow for the usual good power transformer, generally a fraction of one per cent of r. However, again, by varying the choice of r in this narrow range we may vary the distribution of leakage reactance between the two windings. At one extreme, we may put it all into the primary with zero secondary leakage reactance, or we may put it all into the secondary with zero primary leakage reactance.

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Protection Without High-Voltage Switching

AN AIEE COMMITTEE REPORT

IN RECENT YEARS, there has been considerable interest in both the tapping of high-voltage transmission lines to serve various types of loads and in the installation of the transformers on these taps without high-voltage circuit breakers. The necessity of supplying war loads with a minimum use of material provided a great incentive in this direction. Also, the present high costs of construction have increased the desirability of this type of installation.

It is well known that the omission of the high-voltage circuit breakers complicates the problem of providing adequate relay protection for the line and the transformer tapped on the line. In some instances, the omission of high-voltage circuit breakers on tapped transformers makes it impracticable to obtain adequate line protection without the use of carrier-current or pilot-wire relays. Protection for the tapped transformer requires tripping the high-voltage line circuit breakers which may be several miles distant from the transformer. Various methods are in use at the present time to accomplish this function.

In order to obtain information on the types of protective systems being used for the protection of stations without high-voltage circuit breakers, the AIEE relay committee has reviewed the practice being followed by the industry in this type of station. A questionnaire has been circulated covering the principal items under consideration, and answers have been received from a large number of representative companies from various parts of the United States and Canada. The companies submitted detailed diagrams of their installations, and these have been grouped into the representative types shown in Figure 1. The stations without high-voltage circuit breakers can be grouped into two categories; stations that are tapped to high-voltage transmission lines, and stations at which high-voltage lines are terminated without the use of a high-voltage circuit breaker.

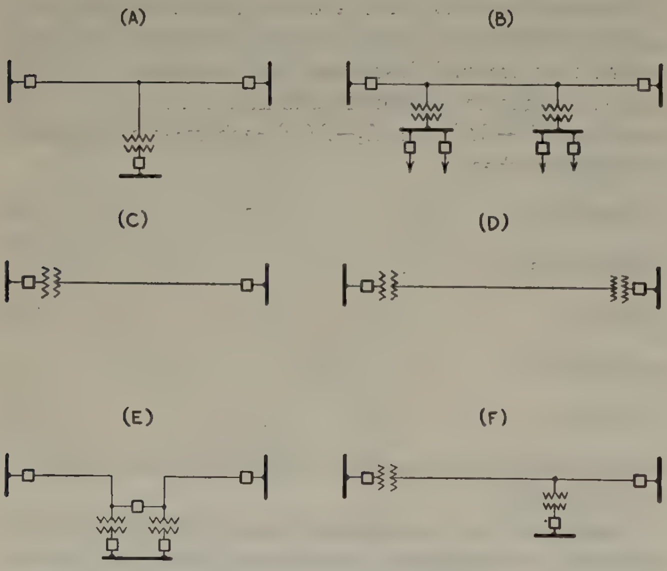

Figure 1. Typical stations without high-voltage switches

The survey was limited to installations where the primary voltage was 66 kv or higher and involved those stations that have no form of local protection, such as a circuit breaker or a fuse. Twenty-five companies from all sections supplied reports covering 169 installations, some of which had been in service up to 25 years.

The answers to this questionnaire indicate use of various methods to trip the remote line circuit breakers for trouble at the station without high-voltage switching. In 69 installations out of the total 169, there is no special method, and the only protection consists of the relays at the main terminals of the line, which are used primarily for line protection. On the remaining 100 installations, the methods used to produce remote tripping consist of special grounding disconnect switches or remote-trip relay schemes, which function either through pilot-wire or carrier-current systems.

The size of transformer does not appear to be an important factor, transformer installations up to 100,000 kva being reported in this survey. Also, the distance from the tap point to adjoining circuit breakers is not a critical item, the distances reported ranging up to 100 miles.

Several installations of the automatic grounding switch were reported. This switch is used to place a phase-to-ground fault on the transmission line when trouble occurs at the local station. The time to close the grounding switch varied from six cycles to two seconds in this survey, most of the installations averaging about 15 cycles.

A large number of remote-trip schemes were reported using either pilot wire or carrier current. The pilot-wire schemes generally consist of initiating a d-c signal by the transformer relays, and sending this signal over pilot wires to the remote stations.

On longer lines, the remote-trip signal is transmitted by carrier current. Since this is a tripping signal, precaution must be taken that tripping will not occur because of fault signals. This can be accomplished by the use of time delay or using a multiplicity of signals.

Practically all companies reported satisfactory experience with this type of installation, although some trouble has been reported with the remote-trip carrier schemes. The general opinion obtained from most companies would indicate that stations without high-voltage switching can be operated and protected successfully.

Digest of paper 49-65, "Protection of Stations Without High-Voltage Switching," recommended by the AIEE relay committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, New York, N. Y., January 31–February 4, 1949. Scheduled for publication in AIEE *TRANSACTIONS*, volume 68, 1949.

Personnel of the project committee: E. L. Michelson (*chairman*), L. F. Ferri, L. L. Fountain, V. J. Hayes, R. A. Larner, K. N. Reardon.

Effect of Fluctuating Load on Steam Turbines

ROBERT L. REYNOLDS

Control of system frequency usually has been considered an electrical problem; however, fluctuations affect the turbine in many respects. This article outlines the reasons for the present interest in the subject of fluctuating load, points out the effect of these fluctuations on the operating conditions in the turbine, and describes design features which permit this method of operation.

THE PROBLEM of maintaining close control of system frequency, while primarily an electrical problem, affects the steam turbine because of the need for fast and accurate adjustment of steam flow through governor-operated valves to suit load changes and, in addition, for designing the steam turbine to assume the resulting changes in steam temperature without serious effect on reliability or efficiency.

Naturally, the ideal way to load a turbine would be to bring it to speed slowly, gradually increase it to full load, and then run at this load for the next two years until it is dismantled for biennial inspection. While ideal from a turbine standpoint, this procedure is, of course, not practicable. However, it is recommended that load changes be made as slowly as practicable, preferably at a rate not exceeding two per cent of rated load per minute; in addition, initial temperature should be changed gradually, preferably at a rate not exceeding two degrees Fahrenheit per minute. On a unit used for frequency control or tie-line load regulation, the load and temperature will change at much faster rates than this, maybe from five to ten times as fast, which means that the turbine design must be made suitable for this condition.

Past practice in central stations generally has been to carry base load on the newer and more efficient turbogenerator units and to subject the older and less efficient units to the rapid and large load changes necessary to control system frequencies.

However, as power systems become larger, these older and smaller stations may not have sufficient capacity or may be in such locations that they cannot satisfactorily perform this frequency-control duty, thus making it necessary for the newer units to assume part, and in some cases, the greater part of the burden caused by load changes. There are several reasons for the use of the older stations for controlling system frequency:

1. The older stations often are located near the center of load. At the time they were built, real estate values were not excessive, adequate water supply was almost always available, and cinders from stoker-fired boilers could be readily disposed of, since they were in demand for construction purposes.

This condition has now changed and will continue to change even more as systems grow larger. Real estate has become too expensive to permit locating the station within, or close to, the city limits. Water requirements have become, in many cases, too great for the available supply which necessitates moving the newer stations to some other source of water. Fly-ash disposal in powdered fuel plants becomes a problem, particularly in thickly-settled areas.

2. To realize to the fullest extent the economic benefits of its lower heat and fuel consumption rates, the more efficient unit should be fully loaded, with fluctuations in load being taken on the more lightly loaded older units.

3. Another reason advanced for the desirability of taking load fluctuations on the older units is that the older turbines, because of operating under much lower steam pressures and temperatures, can withstand rapid and large load changes better than can the newer turbines operating at higher speeds and steam conditions. The older units, usually at least 20 years old, operate at 1,200 or 1,800 rpm and under steam conditions of 200 to 400 pounds per square inch (gauge) pressure and 600 to 750 degrees Fahrenheit temperature. The newer units generally operate at 3,600 rpm except for the larger capacities and under steam conditions of from 850 pounds per square inch (gauge) pressure and 900 degrees Fahrenheit temperature up to 2,000 pounds per square inch (gauge) pressure and 1,050 degrees Fahrenheit temperature.

However, despite the more severe conditions under which the newer turbines operate, they actually can assume the duty of rapid load changes with a greater degree of safety than can the older turbines. The blade speeds are not greatly different; the 3,600-rpm turbine, although operating at twice the rotative speed of an 1,800-rpm turbine, has blade diameters about one-half those of the so-called "slower speed" unit. These smaller diameters also have smaller, more compact casing structures and are suited better to rapid fluctuations in temperature. The materials are better than the materials used in the older turbines so that design safety margins are at least as great, and in most instances considerably greater, than in the older turbines. In addition, construction features are improved so that greater changes in conditions can be imposed upon the turbine with less thermal distortion and safer stresses.

This is particularly true on the working elements, or blades, where the small clearances conducive to small steam leakage and high efficiency are maintained by thin sealing strips rather than the use of the tips of the blades themselves.

For long, efficient operation on the steam turbine, the

Essentially full text of paper 49-98, "Effect of Fluctuating Load on Steam Turbines," recommended by the AIEE system engineering committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting New York, N. Y., January 31–February 4, 1949. Not scheduled for publication in AIEE *TRANSACTIONS*.

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following three conditions must be very carefully considered:

1. Close maintenance of clearances between rotating and stationary elements.

2. Elimination or minimization of thermal stresses and distortions in both stationary and rotating members.

3. Adequate control system to change steam flow to turbine to satisfy load fluctuations.

EFFECT OF BOILER DESIGN

The most serious result of large and sudden load changes on the turbine is the change in steam temperature in the high-pressure section of the turbine. This temperature is affected not only by the inherent changes caused by the change in stage pressures, but also by the fact that the initial steam temperature is reduced at smaller steam flows. In some instances, such as on a unit bought for standby purposes, the boilers are so designed that full steam temperature is maintained down to a rather small steam flow. Such a design, reduces the temperature changes within the turbine.

The curves in Figure 1 show different characteristics in initial steam temperatures plotted against steam flow. Curve *A* is for a unit which is expected to operate at heavy base loads, whereas curve *B* is for a unit operating usually at about ten per cent load as a standby to a hydroelectric system, but capable of taking full load instantaneously in case of failure of the tie line from the hydroelectric system.

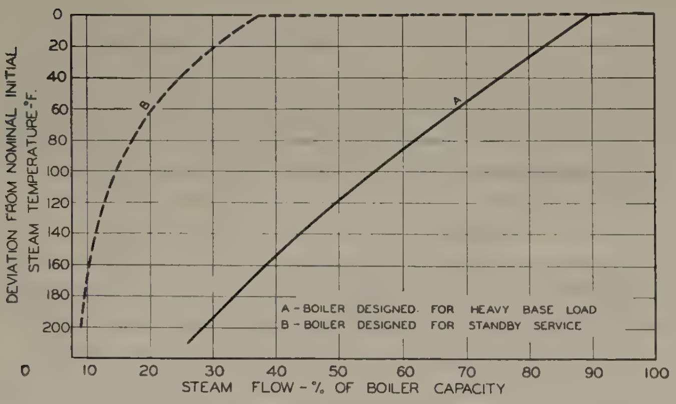


Figure 1. Variation in initial steam temperature to turbine with change in steam flow

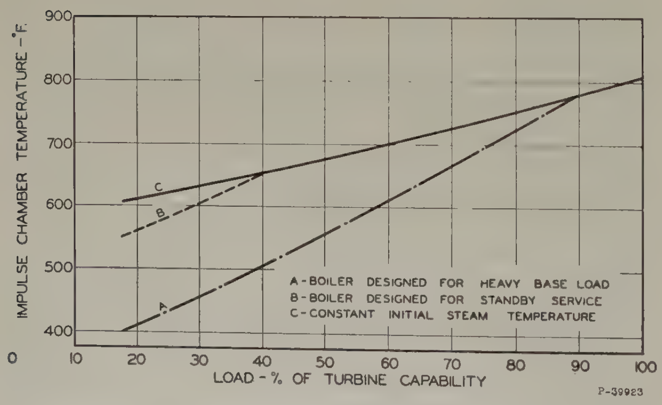


Figure 2. Variation in steam temperature at first stage of turbine with change in steam flow

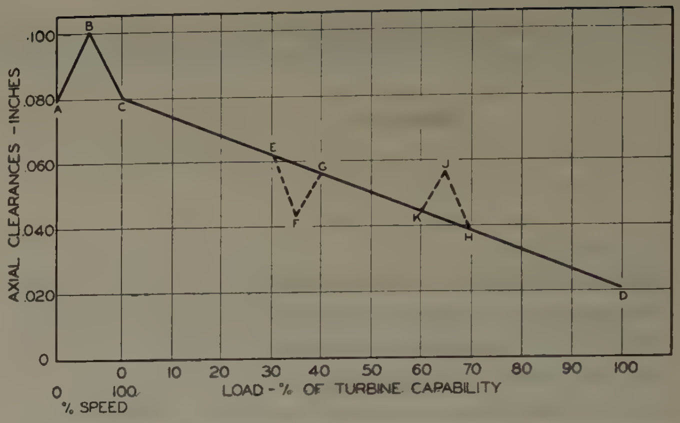


Figure 3. Change in axial clearances in turbine with change in load

The average boiler has a characteristic between these two extremes, with the steam temperature reaching its nominal value at about 50 to 70 per cent of rating.

The curves in Figure 2 show the effect of boiler design on the first-stage temperature of the turbine. Curve *C* is based upon a constant initial temperature, curve *A* upon an initial temperature varying in accordance with curve *A* in Figure 1, and curve *B* upon an initial temperature varying in accordance with curve *B* in Figure 1,

A comparison of the curves in Figure 2 indicates that, with a sudden drop in load from 80 to 40 per cent of turbine capability, the steam temperature on a representative turbine would drop about 210 degrees Fahrenheit with a boiler designed for base load but only about 100 degrees Fahrenheit, or less than half as much, with a boiler designed for standby service. Sudden changes in initial steam temperature affect the turbine in two ways:

1. Changes in axial clearances because of differential expansion between the stationary and rotating parts.

2. Changes in radial clearances, and to a lesser extent axial clearances, caused by thermal distortion of the high-pressure casing.

CHANGES IN AXIAL CLEARANCES

Measurements on a large number of steam turbines indicate that the clearance on axial-type seal strips, which are used only at the high-pressure end, vary in about the manner shown in Figure 3.

During the starting cycle, axial clearances first increase, the amount and rate of increase being dependent upon such factors as initial steam temperature, exhaust pressure, rate-of-speed increase, and turbine design. Further increase in speed causes the axial clearances to decrease until, when full speed has been reached, the axial clearances have become nearly the same as when the unit started to roll.

As load is applied the axial clearances, under steady-state conditions, will follow the solid line *CD*, with clearances decreasing gradually with increase in load.

After determining these axial clearances by actual measurement, the turbine rotor is adjusted so that clearances at the closest position, which usually occurs at maximum load, are sufficient to avoid rubs between the stationary and rotating elements under any condition of operation. Following this initial adjustment the thrust bearing is locked in its proper axial position and no further adjustments are required under subsequent operation.

In case of sudden load changes, axial clearances will deviate from the steady-state line *CD*, as shown by the dotted lines. The increased clearances above the solid line *HJK* occur with sudden decrease in load, whereas those below the solid line *EFG* occur with sudden increase in load. Since the latter condition causes a reduction in axial clearances, it must be more carefully safeguarded against to insure that the high-pressure end axial clearances do not become dangerously small.

HIGH-PRESSURE CYLINDER DESIGN

The cylinder, or casing, of a high-pressure and high-temperature turbine subjected to large and rapid load fluctuations must be made as simple as possible and be of such form that these changes can be imposed without excessive thermal distortion or stresses. To accomplish this, this casing changes in design and construction as the operating temperatures increase.

The various types for 3,600-rpm turbines are shown in Figure 4 for the following initial steam temperatures:

Up to 825 Degrees Fahrenheit. For this range, the steam chest, nozzle chambers, and balance piston rings are integral with the turbine casing. The rings carrying the stationary reaction blading are separate members mounted as shown on Figure 5. Each ring is supported at the horizontal centerline, with freedom to move in and out transversely. Dowel pins at the top and bottom locate the ring transversely, with freedom to move vertically. Axial position is determined by steam pressure forcing the ring against seal rings inserted in the blade ring and in the cylinder.

826 to 900 Degrees Fahrenheit. In this class of steam turbines, the balance piston ring becomes a separate element, mounted at the horizontal centerline and doweled at the top and bottom in the same manner as described for the blade ring.

901 to 950 Degrees Fahrenheit. In this temperature range the nozzle chambers in the lower half also are separated from the main turbine casing.

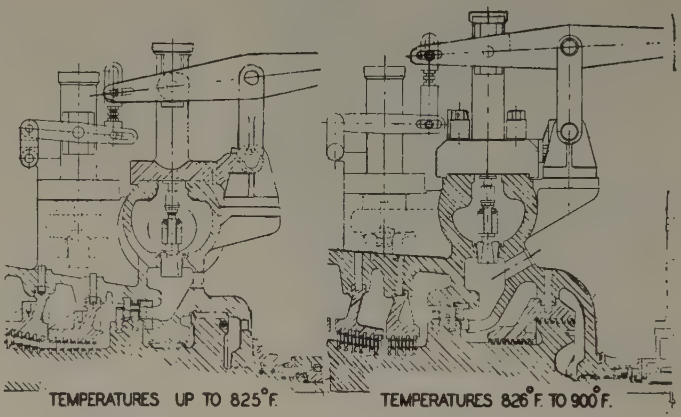
951 to 1,000 Degrees Fahrenheit. When the initial steam temperature exceeds 950 degrees Fahrenheit, the steam chest is removed from the cylinder cover and located either at the side or in front of the unit. Steam is admitted to the turbine through long flexible pipes. In addition, the cylinder is often of double-wall construction, which confines the high-pressure and high-temperature steam within relatively small structures. Nozzle chambers are welded to this inner cylinder through flexible members capable of withstanding the differential expansions involved.

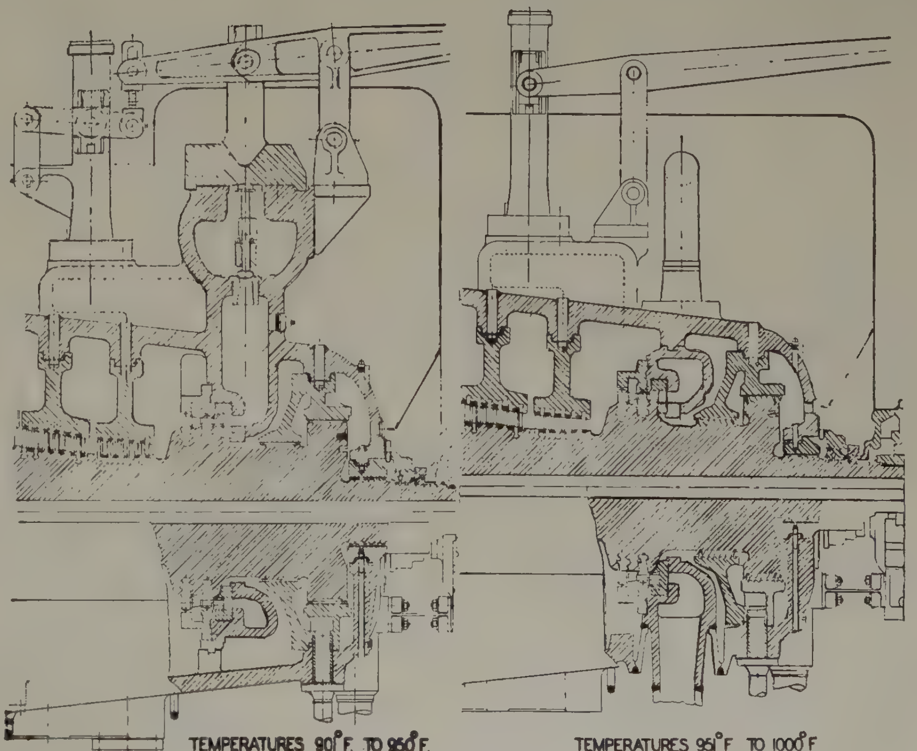
1,001 to 1,050 Degrees Fahrenheit. This construction is similar to that used for 1,000 degrees Fahrenheit steam temperature but with materials suitable for the higher temperature. Such constructions have been adopted to minimize thermal distortions and stresses and, therefore, are usually suitable for the temperature changes which are produced by load fluctuations.

HORIZONTAL JOINT BOLTING

Bolting in the horizontal joint of the turbine casing usually is tightened to an initial stress of about 45,000 pounds per square inch. After a short period of operation at full steam temperature, the bolt material relaxes until residual stress decreases to about 15,000 to 20,000 pounds per square inch,

Figure 4. Modifications in turbine design with changes in initial steam temperature





which is sufficient to provide a margin over the steam load and to keep the joint tight.

A stress of 15,000 pounds per square inch corresponds to a stretch of about 1/2 mil per inch of active length which, in turn, corresponds to the expansion which is produced by a temperature increase of approximately 70 degrees Fahrenheit.

During a sudden loss in load, with its consequent drop in turbine stage temperatures, the inner wall of the casing cools off first, after which the temperature change is communicated through conduction and radiation to the joint bolts. When this temperature drop is sudden and of the order of 200 degrees Fahrenheit, the difference in temperature between the casing and bolting may be temporarily more than the margin keeping the joint tight. Thus the joint may open up and leak steam for a short time, again sealing itself after a sufficient period of operation at substantially steady load and steam conditions.

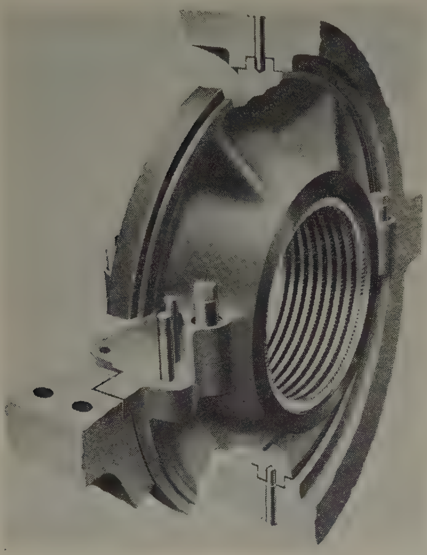


Figure 5. Provision for freedom of expansion with changes in steam temperature

GOVERNOR CONTROL

On a modern turbine equipped with hydraulic governing control, changes in governing impeller discharge pressure regulate, through a transformer or amplifying device, the oil pressure in the servomotor relay which, in turn, determines the position of the governor-operated steam valves. Normal load changes are produced by a speed changer, either hand- or motor-operated, which adjusts the loading of the pressure transformer spring which then changes the secondary control pressure in the servo-motor relay piston and, thus, opens or closes the steam valves to suit.

This method of control lends itself particularly well to the use of automatic devices for controlling system frequency. With such a device, large load changes can be communicated almost instantaneously to a device which changes the secondary control pressure, thus bypassing the comparatively slow speed changer.

In this way, the steam valves can be moved with a minimum of delay to admit more or less steam to satisfy the steam load.

QUICK STARTING OF TURBOGENERATOR UNITS

An associated aspect of this fluctuating load problem is the desirability of returning units to service in the minimum space of time. Extensive studies now are being made to determine how this reduction in starting time can be accomplished most safely.

Results obtained so far indicate that if a turbine is shut down for a short period, as over night, the best method for starting is to admit steam at the temperature of the high-pressure turbine casing and to bring the unit to speed and place it on the line in as short of time as possible, preferably in about 15 minutes. This procedure contrasts with the former practice of rolling the unit at slow speed over a period of one hour or more.

Temperature readings taken at several points on the turbine casing show that the short-time starting cycle actually results in more gradual temperature changes in the high-temperature section of the turbine.

This starting procedure is being studied further on other units and it can be expected, if further analysis confirms preliminary indications, that the starting time can be materially reduced.

SPINNING RESERVE UNITS

Some units, particulary those serving as "spinning reserve" units to a hydroelectric system, operate at light loads, usually at about ten per cent of capacity, but capable of almost instantaneously carrying full load in case of interruption to the tie-line.

Such turbines are equipped with protective devices such as pressure and low-frequency regulators. The purposes of the initial pressure device is to prevent the introduction of steam to the turbine at a rate faster than the boiler can respond without dropping the steam pressure to a point below which steam auxiliaries cannot operate satisfactorily. The purpose of the low-frequency device provides similar protection for the electrically driven auxiliaries by opening the steam valves to a predetermined point and thus obtains almost immediate response when a drop occurs in system frequency.

As pointed out earlier in this article, units operating under such standby service are supplied by boilers designed to keep the temperature changes in initial steam temperatures to a minimum.

SUMMARY

The need for closer control of system frequency, despite more rapid and larger fluctuations in load, definitely demands in many instances that this frequency control be imposed upon the newer and larger central stations and turbogenerator units.

Although more efficient and operating under more severe steam conditions, the present-day turbines generally can withstand these load fluctuations with much greater safety than can the older turbine which were formerly used for this service.

Hydraulic governing control can be adapted readily to the use of automatic frequency-control devices so that extremely close control of frequency can be maintained even with large and rapid load fluctuations.

Digests of Papers at Conference on Electron Tubes in Industry

These are authors' digests of most of the papers presented at the AIEE Conference on the Industrial Application of Electron Tubes, Hotel Statler, Buffalo, N. Y., April 11–12, 1949. These papers are not scheduled for publication in AIEE Transactions or AIEE Proceedings. However, complete transcripts of the papers and written discussions will be made available as a consolidated booklet. Advance orders should be sent to R. S. Gardner, AIEE Headquarters, 33 West 39th Street, New York 18, N. Y., at $3.50 a copy.

Electronic D-C Motor Control; *Ben Cooper (Control Engineering Division, General Electric Company, Schenectady, N. Y.).*

In recent years, electronic d-c motor control has established itself firmly in industry. Although a number of applications were made in the early 1930's, the major growth has been since 1940 with the application of unit drives such as Thy-mo-trol, Mot-o-trol, and the electronic V-S drive. The application of electronics in the control of d-c motors is aimed at bringing out the most useful motor characteristics to fit a particular application. Among the most prominent features are

1. Wide range of speed control.
2. Stepless adjustment of speed.
3. Good speed regulation.
4. Automatic current limit.
5. High reliability.

In addition, the all-electronic unit not only permits the elimination of rotating equipment as a power supply, but also provides a more efficient drive than the conventional motor generator set control. The best applications naturally are those which most fully utilize the characteristics just described. In general, the primary function is to maintain control of the speed of the motor. This may be modified, however, by current limit tension or a number of other functions.

Among the applications of unit drives is a table feed drive for a planer-type milling machine. This particular application requires a speed range in excess of 200 to 1, and an automatic load limit control to prevent overload on the milling cutter motors. Another outstanding application is that of reeling wire in which the use of an all-electric drive increases the output for approximately 300 per cent.

Among the co-ordinated types of drives is the printing press control in which large ignitron rectifiers are used to supply the armature power directly to the press motors. Still another type of co-ordinated drive is the rubber mill calender train. The particular installation in question includes 26 rotating machines each of which has electric field excitation for controlling the speed and tension between the various sections of the train.

In summarizing the present problems and trends, it may be pointed out that there is an increased need for tubes having longer life and greater reliability. Other problems requiring careful consideration include the design and selection of more reliable industrial components, and the simplification of circuit design. For the future, cost will be particularly important, but the possibility of the improvements and increased productivity that can be realized by utilizing electronic motor control offers a distinct challenge to enterprising men of the future.

Electronic Regulators and Regulating Systems; *W. G. Roman (Westinghouse Electric Corporation, Buffalo, N. Y.).*

In developing industrial regulators, the designers have borrowed largely from the practices and the components of the radio and communications field. In a number of instances it has been found that this practice is not wise. For example, the tubes normally used in home radio receivers, although they sometimes have the characteristics desired, are not always found to be satisfactory as far as ruggedness, consistency, and life is concerned when used in electronic control circuits. This problem has been recognized by the tube manufacturers as well as the control designers, and an active program of designing industrial-type control tubes is now under way. Some of these new tubes are already on the market. Other parts such as tube sockets, capacitors, potentiometers, and resistors are being scrutinized by both the control designers and the component manufacturers and big improvements are being made in these parts. The control designer also has found that the high impedance circuits normally associated with electronic tubes are an invitation to leakage currents and stray coupling which can upset the control. Designers are learning to reduce the impedance of circuits wherever possible and also to obtain isolation between circuits in various ways.

Process regulating reaching into all industries is the most diversified of the many uses for electronic drives. However, it has found its greatest use in the continuous process industries such as steel, paper, rubber, packaging, and printing. Regulators inherently operate continuously or very repetitively. Thus, they impose severe duty on any electromechanical device. The use of electronic circuits to perform the precision and repetitive functions, materially improves the performance and reliability of the regulator. Many regulating problems such as automatic color register on multicolor presses could not be made automatic except electronically Process regulators can be divided conveniently into four classes:

1. Quantity.
2. Position.
3. Quantity matching.
4. Position matching.

Quantity regulators regulate the magnitude of things such as voltage, current, frequency, speed, and temperature. A speed regulator of this class would consist of a d-c motor, a motor generator set for supplying the power to the motor, an electronic regulator, and an a-c tachometer generator coupled to the motor for indicating the speed.

Position regulators maintain the location of a physical object within preset limits. A slitter regulator guides a web of material to a chosen location with respect to the cutter by photoelectrically watching the edge of the web or a line printed on the web. A similar device will guide a web on a winder so as to reel evenly. The loop regulator on a paper-coating machine or on a steel strip mill watches the loop position and calls for slowing down or speeding up one of the sections of the mill to maintain a constant loop.

Quantity matching regulators are used to insure that two or more quantities match each other. Frequently, it is desired to adjust the speed, voltage, current, or frequency of one element of a system and have one or more additional elements equal or bear a chosen relation to the first element. This is especially important in continuous processing lines such as steel, paper, rubber, and photographic film. An important example of this type of regulator is the paper mill section drive regulator.

A position matching regulator frequently is used in the paper, cellophane, and glassine packaging industry for maintaining the position of cut when taking stock from a preprinted roll to make bags and packages. Another important application for this class of regulator is for maintaining the register of the several colors in a multicolor printing press.

Electronic Relaying and Photoelectric Control; *F. T. Bailey (Westinghouse Electric Corporation, Buffalo, N. Y.).*

This paper was written to provide an insight on electronic and photoelectric control applications, and the problems encountered with them. Correct application

1948 Electron Tube Booklet

The papers of the 1948 AIEE Conference on Electron Tubes for Instrumentation and Industrial Use, held in Philadelphia, Pa., March 29–30, 1948, as well as the "Report on Electron Tube Survey" prepared by the AIEE joint subcommittee on electronic instruments and containing data on which much of the information discussed at the conference was based, still are available from the AIEE Order Department, 33 West 39th Street, New York 18, N. Y. Prices are $3 ($1.50 to AIEE members) for the former publication, and $2 ($1 to AIEE members) for the latter. However, a special price of $4 ($2 to AIEE members) is being offered to those persons ordering both publications at the same time.

together with the proper type of relays provide results which are difficult to obtain with other electric or electromechanical devices. They are inherently more sensitive, faster in response, capable of operating from low energy input signals. They will operate from small changes in light and they are extremely flexible.

Typical examples of good electronic relays are loom stop motion control for textile mills, iron detectors, and liquid level indicators. These devices obtain their input signals from a high impedance source.

Photoelectric control can be divided into three general classes: on-and-off, light level or intensity, and time and position. The on-and-off type is the most common and generally is used for counting, sorting, limiting, and controlling. On-and-off controls operate from very large changes in light intensity.

The light level or intensity type of control is used when the relay must distinguish between predetermined light levels. Among the applications using this type of control are smoke detectors, illumination control, and others of a similar nature. The general use of light level or intensity relays is not too desirable because they are generally calibrated. Fixed or factory calibrations are impossible to maintain for several reasons. Dust and dirt on the lenses reduce the light. Tubes and lamps have widely varying characteristics and these characteristics change with age. Changes in temperature and humidity affect the consistency of operation.

The third type of photoelectric control is the time and position class which is used to synchronize an operation with an input signal of time and position. Typical of this class of control are the register regulators such as multicolor press register regulators, package wrapping machine regulator, loop regulator, edge controllers, flying shears, and so on. This type of apparatus is used largely where the material to be regulated is moving. The input signal is obtained from printed register marks on the edge of the material.

When electronic relay or photoelectric control is considered for an application, the application must be investigated thoroughly before the proper relay can be selected. In many instances, failure to obtain satisfactory operation from the equipment is due to poor investigation of the application. There is a definite place in industry for this type of control provided the correct relay is used for the application.

The Production and Utilization of Nuclear Fuel; *K. H. Kingdon (Assistant Director of the General Electric Research Laboratory in Charge of the Knolls Atomic Power Laboratory, Schenectady, N. Y.).*

Uranium-235 is the only natural fissionable material which occurs in sufficient quantities to be useful as a practical source of atomic energy. At present, the United States gets most of its uranium from pitchblende deposits in the Belgian Congo. Deposits of carnotite, which contain smaller percentages of uranium ore than does pitchblende, occur in Colorado, but at present do not constitute a large part of our current supply of uranium ore.

Uranium metal of very great purity may be prepared from the ore by a process which includes passing through the "brown oxide" (uranium dioxide, UO_2) and the "green salt" (uranium tetrafluoride, UF_4). This extremely pure natural uranium metal may be used in nuclear reactors such as those at Hanford for the preparation of plutonium, which is an artificially-produced fissionable material. Uranium-233 is a second artificial fissionable material which may be produced in a similar manner to plutonium by using thorium-232 as the starting material instead of uranium-238. The existence of these two artificial elements, or isotopes, probably increases our total supply of nuclear fuel by a factor of several hundred. This possibility will be realized only if reactors are constructed in which the consumption of a given amount of uranium-235 produces more plutonium or uranium-233 than the amount of uranium-235 consumed. Such a nuclear reactor is said to be a "breeder" of nuclear fuel.

Uranium-235 is a relatively rare element but supplies are adequate to guarantee the establishment of a substantial atomic power industry when technical difficulties are overcome.

Nuclear reactors may use as fuel either natural uranium or such enriched nuclear fuel as concentrated uranium-235 or artificially-produced uranium-233 and plutonium. They may operate also with neutrons of fast, intermediate, or slow velocity. The reactor which is under design at the Knolls Atomic Power Laboratory in Schenectady will use an intermediate neutron spectrum and will explore the possibilities of "breeding" with this spectrum. This reactor will use a liquid-metal coolant to remove the heat generated by the nuclear reaction, and will be operated at sufficiently high temperature to generate useful power. The temperature of operation will be kept at the minimum possible for producing useful power. For example, a coolant temperature of about 600 degrees Fahrenheit will make it possible to generate electric energy with an efficiency of about 25 per cent. The temperature will be kept as low as possible to minimize corrosion and other problems.

It is likely that the first practical application of atomic power will be the propulsion of ships and a great deal of effort is being organized in this direction. The task is, however, a major one, and it is likely that several years must elapse before the first atomic-powered ship will be in operation. The development of land plants for the generation of electric power from atomic energy probably will proceed at a somewhat slower rate, and it is likely that some tens of years will elapse before any appreciable part of our total power supply is derived from atomic energy.

Functional Life Tests of Vacuum Tubes; *J. L. Wagner, K. S. Koon (Electrical Laboratories, International Business Machines Corporation, Endicott, N. Y.).*

The industrial user of tubes is directly concerned with tube life and performance. As the volume of tube usage increases it becomes important to determine tube life and to test competitive brands. Such a study indicates that certain tube types, when used in particular circuits, may give short life. This behavior is anomalous and apparently not too well understood or controlled by the manufacturers. An analysis of tube rejects can be tabulated to illustrate the weak points in present-day "radio" tubes which limits their utility in industrial applications. By eliminating a few of the major defects the present radio tube could be converted into an "industrial" tube with acceptable performance and still be sold at reasonable prices.

In the application of tubes it is logical to expect that the life of a tube can be extended tremendously by reducing the anode current to a minimum. This, however, may be an erroneous assumption, as can be proved.

Data can be assembled showing the causes of rejection of tubes in the receiving inspection department, the tube failures which occur in operation on machines in service, and how closely laboratory results corroborate field experience.

In particular, data have showed that tubes from one manufacturer will excel in one respect yet be inferior in others to those of other manufacturers. For instance, the tubes from one manufacturer were very bad when operated in a biased off condition, yet satisfactory in comparative life when operated with an inductive load.

Evidently there is a definite need for each industrial user of tubes continuously to test his tubes for suitability prior to large-scale use in applications in the customers' offices.

The information presented in such data is of considerable economical value to the manufacturer. It further demonstrates that such information is valuable to the electronics engineer. Even yet, there is practically no handbook or published literature on tube life. This situation is frequently embarrassing to the engineer who attempts accurately to direct his design to achieve long life and reliability, for instance, if a tube is used at half load, will it last twice as long?

Tube Ratings as Applied to Industrial Equipment Design; *O. W. Livingston (General Electric Company, Schenectady, N. Y.).*

The objective of this paper is to make the industrial equipment designer realize the importance of tube ratings, to make him aware of the serious limitations in the ratings of certain types of tubes, and to convince the tube designer of the desirability of adequate fundamental ratings to remedy some of the present deficiencies.

The term "tube rating" is defined broadly to include all of the information supplied by the tube manufacturer which gives not only the maximum and minimum values of applied conditions, but also the maximum variations of any characteristics within a reasonable life period, either guaranteed or expected. The equipment designer should design his equipment to work satisfactorily with any tube covered by these ratings. The still too common practice of checking an equipment with a dozen tubes to see if it performs satisfactorily is entirely inadequate to indicate the troubles that may be experienced with tubes of other current manufacture which may have different "undefined characteristics," effects of life on characteristics, and possible changes in tube construction in the future which may alter these "undefined characteristics."

The fact that tubes are replaceable items in equipment that should have a useful life of 10 to 20 years makes any testing by the equipment designer inadequate. If a characteristic limit is well defined by a reputable tube manufacturer, any specific tests by the equipment designer are unnecessary; if the characteristic limit is not defined, the tests are of little value. "Improvements" in tube construction may change these "undefined characteristics" at any time, and if dependance has been placed on them, serious difficulty and perhaps expensive modification of the equipment may result.

The actual "performance ability" of a tube may be considerably different than its rating in several respects. In general the rating should be more conservative to take care of variations among tubes, and with life. The "performance ability" may be very complex to express completely and accurately, but the rating must be simple, definite, and readily understood, even if it prevents the use of the full "performance ability." As new applications develop it may be found that such arbitrary ratings unnecessarily penalize the tube and it sometimes becomes desirable to make the rating somewhat more complicated to permit use of this ability. This is a perfectly acceptable procedure as long as there is no "cut back" in ratings already established.

There are two basic types of ratings which might be referred to as "fundamental" and "application" ratings although some ratings may be a combination of both. A fundamental rating is one in which the limiting applied conditions and characteristic variations are specified in such fundamental terms as voltage, current, wattage, time, and temperature without reference to any particular use, circuit, or circuit components or circuit conditions.

Wherever possible the fundamental ratings are desirable as they may be applied to the wide variety of circuits and uses typical of the industrial control field. There are instances, however, particularly in new applications, where the fundamental ratings do not adequately express the tube performance ability that application ratings are convenient, although every effort should be made to integrate them eventually into a more adequate fundamental rating.

The use of electron tubes in industry has passed the experimental stage. In order to put this equipment on a sound engineering basis more complete ratings are necessary, particularly in the small high vacuum tubes. With such ratings the equipment designer then should be able to design equipment with a reasonable assurance that it will not only perform but continue to perform successfully over the normal life of such equipment.

Problems Related to Industrial Electronic Equipment Design; *Roland Russo* (*The Clark Controller Company, Cleveland, Ohio*).

With wider acceptance in the application of electronics in industrial control the problem of designing an industrial electronic device is more complex than is normally the case. Industrial devices must perform perfectly under a rather broad range of conditions. Since performance and reliability of the device are dependent upon the proper functioning of the electron tubes and associated circuit components, it is essential that intelligent application of available components be employed.

Rugged industrial components to withstand extreme variations in temperature and humidity, continuous vibration and shock, corrosive and sooty atmospheres, are required by the designer of industrial electronic equipment if he is to produce a device that is acceptable to the industrial field.

The trend in industrial electronic equipment design is to conform to National Electrical Manufacturers Association Standards and Specifications, to eliminate soldered connections as much as possible, and to allow for easy routine maintenance by nontechnical personnel. The outstanding trend is that of eliminating soldered connections so that troubles which might be incurred through faulty soldering are eliminated and so that servicing in the field is made easier. The use of components to which a bolted screw connection can be made is therefore to be employed as frequently as possible. Attention of the manufacturers of electronic components is invited to this particular point so that measures may be taken to assure that such components can be made available to the electronic equipment designers.

Much has been done by the various electronic component manufacturers in recent years to provide the industrial control field with components which will withstand the severe conditions of this field of application. The need for additional industrial components and for expanding present lines is quite urgent. In particular, however, there is need for improved tube cap connectors for Radio Manufacturers Association medium *Cl-5* size caps, resistor mounting boards with screw terminals; compact feed through terminal strips with screw terminals on both sides; compact disconnect plugs designed for easy insertion or removal; small encased paper capacitors with screw terminals; variable resistors or potentiometers less than 25 watts with increased insulation between terminals and from terminal to case and with improved mechanical design and screw-type terminals. Other components desired are a standard line of filament transformers for use with the more common types of industrial thyratrons, ignitrons, and phanatrons, and an inexpensive adjustable time delay relay for tube filament preheating and a small circuit breaker with tripping characteristics matching the current ratings of the common industrial rectifiers.

It is evident that the components in a given electronic device serve important functions in assuring troublefree operation of the device, and that there is much the component manufacturers can do to enable the designer to produce a device that meets the rugged and varied requirements of this field of application.

Tube Application Problems in the Design of Industrial Electronic Equipment; *Anthony P. DiVincenzo* (*Reliance Electric and Engineering Company, Cleveland, Ohio*).

The purpose of this paper is to discuss some of the difficulties, other than those which arise from tube ratings or characteristics, which have been experienced in the application of electronic tubes to industrial control equipment. The comments are limited to the octal socket radio receiving type tubes, and the gas-filled and mercury-vapor rectifiers, both thyratrons and phanotrons with average current ratings of 0.5 to 6 amperes.

One of the major sources of troubles with tubes available for industrial electronic equipment is mechanical defects. Gas and mercury-vapor tubes with glass envelopes have numerous defects such as loose plate caps, loose bases, and insufficient internal mechanical rigidity of anode.

Another problem is the necessity for standardization of the gas and mercury-vapor filled tubes. Standardization of bases, tube designations, and heater voltages is urgently needed.

There is also the problem of heater voltage limitations. The present tubes available have too narrow a cathode temperature operating range. It is necessary then, for the equipment designer to go to added expense and circuit complexity to overcome these limitations. As one of the primary objections to the use of electronic tubes in industrial control is short life, it seems advisable to increase the cathode temperature range of industrial electronic tubes and increase their life expectancy.

Still another problem is the need for more complete published data on tubes. Specifications on how the tube is to be used and expected tolerances would be very helpful. For vacuum tubes, such data as expected variations in tube characteristics with heater voltage variations, and heater-to-cathode impedance would be very helpful. For the gas and mercury-vapor filled tubes, the maximum arc-drop specifications, and the conditions for testing and uniformity of the testing procedure is needed also.

Ratings of Ignitron Tubes for Rectification; *H. C. Steiner* (*General Electric Company, Schenectady, N. Y.*).

Sealed ignitron tubes are used in rectifier equipment of 50 to 1,000-kw capacity at 300–600 and 900 volts direct potential. Continuously evacuated ignitron rectifiers have capacities of 1,000 to 3,000 kw in the same voltage range while at higher voltages as used in radiobroadcasting and frequency converters sealed-tube rectifiers have capacities of 1,000 to 7,500 kw.

The size of sealed ignitron tubes is determined by the power rating of the complete rectifier. The rectifier circuit is usually of the 6-phase double-Y or 6-phase double-way type and requires six rectifying elements. Tubes of 100-, 200-, and 400-ampere ratings at 300 volts d-c output provide the desired rectifier capacities. The power or kilowatt capacity of the tubes is constant or increases as the voltage level is raised so that these tube sizes provide the desired rectifier capacity over the desired voltage range.

Ratings are the stated or assigned values of the tube's capabilities. Ignitron tube ratings are stated in terms of maximum values—such as maximum peak, average, and surge or fault current—describing limiting conditions of operation, or requirements.

To determine tube current capacity, load-limit tests are made by operating the tubes in rectifier equipment having a mode of operation and circuit constants comparable to those occurring in actual service. Such tests for assigned parameters of minimum and maximum water-cooling temperatures, phase control, inverse voltage, and so on, provide data from which curves may be drawn that describe characteristics and ratings.

Consideration and understanding of the

ratings and application within the limits specified will result in the attainment of maximum tube performance and life.

Electronic Control of A-C Power; *E. W. Hutton* (*General Electric Company*, *Schenectady*, *N. Y.*).

As alternating current is used almost universally in the United States for the transmission of electric power, and as the majority of equipments that convert electric power into useful work are operated by alternating current, control of that power is an important problem. Functional requirements of the control may range from simple on-off operation to continuously variable, completely automatic and extremely accurate performance. The control must be economical and dependable.

Electron tubes may be employed to fill many requirements for a-c power controls in both power-handling circuits and for regulating and controlling functions.

Three basic power circuits may be used to control alternating current. In each circuit the controlling means acts like a variable impedance. Several basic circuits employing electron tubes may be used for the variable impedance in any of the power circuits. Each of these circuits has certain characteristics which affect tube selection and performance. A knowledge of these factors is required for successful application.

Well-known applications of electronic control of a-c power include electronic contactors for resistance welding, electronic circuit breakers for extremely fast interruption of alternating current, control of wound-rotor induction motors over wide speed ranges, current and voltage regulators of many varieties, control of industrial electric furnaces, and control of theater and display lighting. Each of these equipments is characterized by low control power requirements, high efficiency, flexibility, accuracy, and dependability.

Gas-Filled Thyratron Rating Methods and the Use of Ratings in Application; *D. V. Edwards* (*Electrons*, *Incorporated*, *Newark*, *N. J.*).

Gas-filled thyratrons were introduced in 1930 to improve reliability by eliminating the effect of ambient temperature on tube life, characteristics, and ratings. Their acceptance is the result largely of their constantly growing dependability. This improvement has been brought about as much by better understanding of the rating problem as by improved design and manufacturing control.

Life tests at rated current and voltage did not correlate with life experience in service. More subtle causes were responsible for premature failures while the ratings were being developed.

The final factor determining all ratings is life test under as many simultaneously applied rated duties as possible. End of life is reached when the tube fails to meet any rating or any characteristic drifts out of range. Tube life is statistical, hence ratings must be based on statistics.

There are some ratings peculiar to gas thyratrons. To insure against gas clean-up, a commutation factor rating is required. This rating is so high that circuit duty only can approach the tube rating in applications when high inverse voltage exists and continuous current flows throughout the cycle. Recent tubes have materially higher commutation factor, making it unnecessary to check commutation duty, unless the anode supply voltage has low impedance. If necessary, circuit duty may be reduced by adding capacitor resistor cushion circuits.

A minimum grid resistor rating is required, or else a complex series of ratings to set a maximum to the permissible grid bombardment during the various discharges. Short-circuit current ratings have been given in slightly different form than is customary in mercury tube practice. Methods of rating deionization time have not been entirely satisfactory. A new test based on operation at high frequency in a wattless inverter circuit is being tried in rating a recent tube.

Development of a prototype unit includes eliminating "noise" or extraneous grid voltages picked up from the power end of the system. Some "noise" may come through grid anode capacitance, hence this is specified. A far larger and more common path is through the capacitance between windings of transformers in the grid circuit, a factor which is usually unmentioned in the transformer specifications.

D-c reading oscilloscopes with low stray capacitance from power source to ground terminal greatly expedite unit checking. Peak forward, peak inverse voltage, and deionization time are visible under all operating conditions with the oscilloscope connected from cathode to anode. The grid float voltage, maximum grid voltage, critical grid voltage, peak forward and inverse voltage, and critical anode voltage and arc drop are displayed when grid-cathode voltage is applied to the vertical oscilloscope plates and anode-cathode voltage to the horizontal plates under all operating conditions. Commutation factor is measured with the scope from anode to anode.

In conclusion, rating methods have been developed and tried in practices for several years, which, when properly used, remove uncertainties of unit development and allow full advantage to be taken of the quick heating characteristics of gas thyratrons, and of their adaptability to clean and compact totally enclosed cabinets.

Selection and Use of Capacitors in Electronic Control Equipment; *W. J. Thacker* (*Capacitor Division*, *General Electric Company*, *Pittsfield*, *Mass.*).

Millions of dollars and thousands of man-hours have been devoted to the development and design of capacitors for a multitude of applications. Today we have paper capacitors impregnated with waxes, liquids or resins; also mica, ceramic, plastic film, glass, liquid, gas, air, and electrolytic capacitors. Each of these has characteristics which best fit it for specific applications. Numerous misapplications however reveal a lack of a true understanding of the operating range and properties of the various types.

The armed services are to be credited for their work in conjunction with industry in the preparation of specifications for capacitor components. Specification *JAN-C-25*, one of several such specifications in existence, specifically covers capacitors of the hermetically-sealed metal-cased paper type. While capacitors to this specification are required on equipment for end use by the armed services, it usually will be more economical to use commercial-type paper capacitors for civilian industrial application. Standardization of these capacitors is now under consideration.

The paper capacitor is the most versatile of the various types used in electronic control equipment. It falls in between the electrolytic and mica capacitor from the standpoint of manufacturing tolerance in capacitance, stability with temperature and frequency, aging, and ability to carry high currents. The characteristics vary with different impregnants and should be taken into account for each application.

In general, the commercial types of hermetically-sealed metal-cased paper capacitors commonly available are satisfactory for low-frequency filter, blocking, and bypass applications. Their characteristics and operating limitations are fairly well covered in manufacturers' literature. Applications of paper capacitors involving arc suppression across d-c contacts or pulse applications involving energy storage and discharge are those which often give the user trouble. Arc suppression may expose the capacitor to very high surge voltages while in energy storage and discharge use high currents and heating, especially where reversal of polarity is involved, become a factor. For such applications, it is well to give the capacitor manufacturer complete details on the proposed application and solicit his recommendations.

The capacitor should be regarded as a device which provides more than mere capacitance. It has specific electrical and mechanical properties. Because all of the desirable properties are not combined in any one type of capacitor, it is usually necessary to compromise in the selection of the required unit. For electronic control equipment the selected capacitor must possess the required characteristics initially and retain them through relatively wide temperature ranges, under 24-hour duty cycle and under adverse conditions of vibration and moisture. A complete knowledge of the operating conditions and of the characteristics and properties of capacitors is necessary for their proper use. It is always good policy to consult the capacitor manufacturer on questionable points. The capacitor is an engineering tool which can do a real job when properly applied, but like other apparatus can cause much grief when improperly used.

Desirable Improvements in Tube Characteristics and Ratings; *E. H. Vedder* (*Westinghouse Electric Corporation*, *Buffalo*, *N. Y.*).

The two basic requirements for industrial tubes are that they be truly industrial and that they continue to be available and free from change for long times since the life of industrial apparatus is 20 or more years.

To be truly industrial, tubes must be designed with industrial standards of insulation, voltage tolerance, stability, life, and predictability of characteristics. The National Electrical Manufacturers Association Industrial Control Section has adopted a standard for insulation distances which takes into account electronic problems. Tube designers should conform to these standards.

Voltage tolerances permissible for filament supplies should be raised to plus or minus ten per cent instead of the present plus or minus five per cent. This agrees with standard industrial practice for other devices. If the wider tolerance penalizes ratings, performance, or life, then two sets of data should be given to permit the circuit designer to choose intelligently how to apply the tube.

Many tube applications require extreme dependability and stability of performance and characteristics. Life and stability should be improved to permit use in applications such as mills where outage time is expensive. The greatest need for improvement is in high vacuum tubes commonly thought of as the receiver type and which are now one of the major causes of trouble in exacting applications. The development of a suitable line of high vacuum tubes will require close co-operation between the tube and equipment designers on an industry-wide basis. It is especially important that factory tests of tubes be adapted to industrial problems. Testing by methods considered satisfactory for radio tubes frequently does not tie down the important characteristics such as balance between sections of a twin tube.

Desirable improvements in ignitron tubes are development of air cooling and low ignitor firing energy.

Thyratron development should be toward inert gas tubes with longer life and elimination of the need for buffer circuits to prevent cleanup of gas.

Costs of the larger tubes should be reduced to make them more competitive with other methods. The cost of smaller tubes is usually not serious and in fact could be increased in most instances to get a better tube.

The program outlined will require years to achieve but the expansion of the industrial electronic business depends on the very things outlined. Magnetic amplifiers are being considered seriously as a means of getting rid of the present shortcoming of tubes. Tube and equipment designers must design tubes and circuits measure up to industrial standards of reliability if we are to get beyond the point of tube apparatus merely being tolerated when other devices cannot be made to work at all.

Phototube Characteristics; *Alan M. Glover (Radio Corporation of America, RCA Victor Division, Lancaster, Pa.).*

The application of phototubes has been increasing widely in recent years based on reliable performance in such early applications as printing registry, sound on film, and safety control devices. Multiplier phototubes particularly are being incorporated in scientific instruments. Phototubes are classified most readily by their spectral response—the *S-1*, sensitive in the infrared and red end of the visible spectrum, and the *S-4*, sensitive in the blue end of the visible spectrum, being the most popular.

Limitations to the use of phototubes are the inherently low output sensitivity and the presence of fatigue which is a function of anode current. Fatigue may be overcome by reducing anode current and the anode voltage applied to the tubes at sacrifice in sensitivity.

The last few years have seen a marked increase in the use of multiplier phototubes as knowledge of the most satisfactory method of use has become more widespread. The limitations in this type of tube are spread in output because of the large variation in gain of the secondary-emission amplifier stages, fatigue at current levels in the order of one milliampere, geometry of the cathode or light-sensitive area. Operation of the tube at levels below 100 microamperes usually results in sufficient freedom from fatigue and, fortunately, the spread in output may be accommodated by control of the voltage supply.

The multiplier phototube permits operation to light levels limited only by the dark current of the tube. This dark current is made up of ohmic leakage, thermionic emission, and residual gas ionization. With the use of a-c amplification and chopped-light sources and operation at voltage sufficiently low to prevent the last effect, multiplier phototubes can detect photo currents in the order of 10^{-16} ampere without refrigeration.

District Papers Digested for South West District Meeting

These are authors' digests of most of the District papers presented at the AIEE South West District Meeting, Dallas, Tex., April 19–21, 1949. These papers are not scheduled for publication in AIEE Transactions or AIEE Proceedings, nor are they available from the Institute.

The Design and Construction of Transmission Structures; *Ralph G. Yerk (Hughes Brothers, Inc., Seward, Nebr.).*

The efficiency of the modern power plant and the progress in other fields of electrical service have presented the transmission engineer with a challenge to design and recommend line construction of equal reliability.

Through the combined efforts of many of the United States' leading transmission engineers, there has been a noticeable improvement in the design and construction of transmission lines, resulting in greater reliability and better operation.

Research and operating records from existing construction indicate that by proper proportioning of the length of insulator strings, the number and location of ground wires, the separation of ground wires from conductor, and the reduction of ground resistances by the installation of ground rods or counterpoise, practically 100 per cent of the lightning strokes on transmission lines of 69 kv and higher can be controlled so that they do not cause an interruption. The same is true of lines of less than 69 kv but the cost of complete control may not be economical. Actually, the degree of lightning protection is limited only by the money which can be spent for that purpose.

Full size structural tests and the experience gained from recent sleet storms have indicated the weak points in the earlier conventional designs. Internal bracing has proved beyond question their advantages over internal guys and as a definite improvement over unbraced "H" frame construction.

A well-designed fully braced type of structure often will result in a more economical over-all line than will the use of the formerly conventional single pole or an unbraced type of structure.

Maintenance costs are reduced greatly through the selection of modern equipment for the original installation.

Better operation can result from rehabilitating existing construction by adding shield wires, locating shield wires properly, providing wood for impulse insulation, or increasing the mechanical strength by modern bracing methods and equipment.

Universal standardization of transmission construction seems somewhat impractical. Light, medium, and heavy loading zones dictate to some extent the structural requirements, and the type and importance of the load being served quite often limit the design engineer as to the method of construction applicable. However, experience has shown that the absolute minimum, in so far as the initial investment is concerned, may result in excessive maintenance, repair, and unsatisfactory operation to the extent that a slight additional investment in the interest of better design and construction would have produced the most economical service during the life of the line.

A New 3-Channel Stackable Carrier Telephone System; *D. G. Clifford (Lenkurt Electric Company, Inc., San Carlos, Calif.).*

Present greatly increased cost of construction of wire line facilities, together with ever-increasing demand for circuits, greatly has stimulated the demand for carrier equipment, since it has become the economical solution of providing additional facilities. To meet the requirements of independent telephone companies, oil and pipe line companies, railroads, and public utilities such as gas and electric companies, the Lenkurt Electric Company has designed and is manufacturing a new type-*33* 3-channel "stackable" carrier system.

This system is sufficiently economical in initial cost and subsequent maintenance to justify installations over distances as short as ten miles, and provides three additional speech channels over a physical pair. All though its cost justifies its use for short distances, the gain is sufficient to permit working over a 32-decibel circuit with a 6-decibel equivalent loss, making it fully satisfactory for moderate distance service. Repeaters can be added on a per channel basis and fully qualify the system for long-distance use.

Simplification of design, use of a minimum number of tubes, and conservative ratings on all components make this system ideally suited for use by personnel not highly skilled in carrier techniques. Stability of level and frequency, simplification of adjustment, and the availability of complete prewired assemblies of terminals to customer specification greatly reduce problems of installation and initial lineup.

Line filters are furnished as separate units to enable their use as junction filters and for installation at terminals and repeaters at locations other than the carrier bay. One 3-kc low-frequency cutoff line filter is required for a 3-channel terminal, and additional line filters may be had with cutoff frequencies of 12 kc and 24 kc. Use of these latter two filters permits terminating one or two channels at intermediate points. For example, the first channel might be used to provide a through trunk circuit over a 150-mile lead having two intermediate points. The second channel might be used to provide a through circuit to the second intermediate point and again to provide a local circuit from this second point to the distant terminal. The third channel then could be used to provide local independent circuits between all points. The stackable feature of this type-*33* carrier system is ideally suited to this and similar application problems.

Repeaters having 30-decibel gain are also available on a stackable basis so that any desired channel can be repeatered when and if required.

Pilot regulators are available for the second and third channels when required. Use of pilot regulator panels adds five decibels additional receiving gain at a terminal, and also provides automatic synchronization of the regulated terminal. Variations of received level from +4 decibels to −16 decibels are corrected within approximately ±2 decibels. Pilot regulator panels are also available for repeater installations.

For installations where two 3-channel systems are required over a phantom group, a complete series of terminals and repeaters for the second and third channels with an inverted and staggered frequency allocation in respect to the standard system is available. This reduces any crosstalk interference to unintelligibility.

The versatility of this new system greatly enhances its usefulness to those responsible for increasing circuit facilities. The system co-ordinates in frequency allocation with American Association of Railroads agreement, thus permitting use with other standard carrier systems already in service.

Considerations in the Engineering and Construction of a Coaxial Cable Route; *W. E. Haywood (American Telephone and Telegraph Company, St. Louis, Mo.).*

There are several engineering considerations which are of prime importance in the provision of any new coaxial cable route.

A primary requirement of such a route is an expected large volume of toll telephone traffic through the particular cross section. The provision of coaxial cable is uneconomical where only small numbers of toll telephone circuits are needed.

Accessibility to the coaxial route, and to the amplifier stations spaced at approximately eight mile intervals along it, is quite important in order to facilitate and expedite trouble clearing and other maintenance operations. The cable route is, therefore, generally along all-weather roads.

Placing the coaxial cable underground is necessary for transmission reasons. Coaxial systems cover wide frequency ranges and it is not practicable to provide equalizing and regulating systems to cover the wide variations in transmission loss due to temperature changes in aerial plant.

As many as 1,200 toll circuits are carried by a coaxial cable (600 per pair of working coaxials) and protection of service is of paramount importance. Coaxial cables are, therefore, generally buried along private property, far enough removed from the highways and buildings to be safe from normal grading and digging activities. Burying the cable also gives it a greater degree of protection from the elements, fire, bullets, machinery, and so forth.

Many protective devices are incorporated in the cable layout and in the coaxial system itself, some of which are enumerated in the following:

1. Variations in transmission are largely compensated for by means of automatic regulators spaced at intervals along the route, under the control of pilot frequencies transmitted from terminal stations.

2. The amplifiers at all points use parallel electronic tubes in each stage, so designed that the failure of one tube (in either stage of amplification) will not affect the gain of the amplifier appreciably.

3. Automatic engine alternator sets are provided at power supply points to protect against extended failures of commercial power supply.

4. D-c driven automatically-operated motor alternator sets at these points protect against short failures of the a-c commercial supply.

5. A gas pressure alarm system warns of lead sheath ruptures and, in many instances, prevents service failures pending the repair of such openings.

6. Transmission over two lines simultaneously guards against service interruption due to failure in either transmission path.

7. Special coverings are used over the lead sheath to lessen the possibility of damage resulting from electrolytic corrosion, low-frequency induction, lightning, floods, rodents, and so on.

8. Special consideration is given to erosion control as the maintenance of the protective earth cover is important.

In urban areas, the cable is placed in underground conduit. Outside of urban areas, the cable usually is buried in the ground. Special plowing equipment is used which is capable of burying the cable as much as 48 inches beneath the surface, although depths somewhat less than this generally are used. Burying the cable at these depths is sufficient to protect it against normal cultivation or other routine operations on the earth's surface.

At stream crossings the cable is particularly vulnerable, especially during floods. Special care is taken, therefore, in the design and installation of the cable at these points.

Distance Carrier Current Relaying; *A. J. Nicholson (Kansas City Power and Light Company, Kansas City, Mo.).*

This presentation covers the problem in providing successful protection on a transmission line of 69 and 161 kv between Kansas City, Mo., and Moran, Kans. This system includes the interconnection of a small generating plant with a large system which involves unusual relaying problems to provide proper protection. The large generation at Kansas City will furnish plenty of short-circuit current for all types of faults to give reliable carrier relay operation at all terminals in direction toward the Moran area. However, with the present small generation in the Moran area there would not be sufficient short-circuit current to operate relays in direction toward Kansas City, but the small generation may maintain voltage on the arc.

The General Electric Company engineers designed a relay system to meet the foregoing extreme short-circuit conditions and which gives high-speed carrier current pilot relaying for all types of faults. In addition to the usual carrier current relays, a set of phase undervoltage relays are provided at each terminal as a means for fault detection and tripping or blocking as required.

The undervoltage relays on all terminals looking toward Moran are set at 90 volts to start carrier to block tripping on external section faults. The undervoltage relays on all terminals looking toward Kansas City are set at 30 volts to initiate tripping on internal faults if no carrier is received from the opposite end. This spread in voltage settings is necessary so that on all faults the carrier will be started first for blocking. On internal section fault, and with plenty of short-circuit current from Kansas City, the directional relays will stop carrier permitting the Kansas City end circuit breaker to trip and also will permit the 30-volt relays to trip the Moran end circuit breaker. However, on external section faults, carrier will not be stopped and the respective section circuit breakers will not trip.

Supervisory is provided in which the selection, checking, and operation are performed automatically by codes transmitted over the relaying channels. At the time the dispatcher desires to operate a circuit breaker, he pushes the control switch assigned to the prospective circuit breaker and holds it in the operating position until the change in the indicating lamps shows that the operation is completed. From the viewpoint of the dispatcher, this is a simplified operating scheme over those previously offered.

The Combustion Gas Turbine and Its Application as a Prime Mover for the Generation of Electric Power, and Other Uses; *B. G. Hatch (General Electric Company, Schenectady, N. Y.).*

Activity in the development of the combustion gas turbine has aroused a great deal of recent interest, particularly with those whose activity is in the generation or utilization of power.

The combustion gas turbine is a complete power plant for the conversion of energy from fuel directly into electric or mechanical power. The simplicity of the unit itself and the required fuel auxiliaries, together with the elimination of requirement for large quantities of water, and of secondary heat transfer equipment such as boilers, condensers, miscellaneous pumps, fans, motors, valves, and other accessories would suggest many possible applications for this new type of power generation equipment. There are many possible cycles available, with various combinations of secondary heat transfer equipment, with or without water cooling, to permit the most flexible choice of application and selection of efficiency for each installation.

The combustion gas turbine is particularly adaptable as a remote automatic or semi-automatic power plant. Its starting functions are very nearly automatic, and require a minimum of supervision. It is therefore particularly favorable as an end of line plant, to stabilize load and to promote load growth in remote areas. A parallel application would be as a standby or peak load plant.

Because of the simplicity of the foundation and minimum housing requirements, either the 3,500-kw simple-cycle power plant which requires no cooling water, or the 5,000-kw high-efficiency power plant which requires about 1,200 gallons per minute could be arranged for mounting on railway cars as emergency or portable power plants or for planned service outage use to permit regular system maintenance in usual working hours, rather than on a weekend or overtime basis. A 5,000-horsepower simple-cycle gas turbine power plant already has been mounted in a 4,500 traction horsepower locomotive, and has had several months' operation on the rails.

The possibility of large-scale economical secondary heat recovery with the simple-cycle unit, which can generate 20,000 to 25,000 pounds per hour of low-pressure secondary steam through a nonfired heat recovery boiler, will open up many applications requiring heat recovery in conjunction with industrial process work. In special instances, the combustion gas turbine can be applied to improve the heat balance or to supply additional steam in an existing low-pressure steam station.

With 5,000 horsepower of mechanical energy available in a single power plant only $19^1/_2$ feet long and weighing about 25,000 pounds, the simple-cycle unit would appear to offer an ideal application for natural gas pipe line or high-pressure oil pipe line pumping, when used with suitable external centrifugal compressor or pump. When so applied, the combustion gas turbine can operate directly from the natural gas or oil from the pipe line as fuel.

Distribution Line Protection Fuse and Relay Co-ordination; *J. P. Barron (Dallas Power and Light Company, Dallas, Tex.).*

The use of higher voltage, in the order of 12–13 kv, for distribution circuits, with the attendant increase in circuit exposure, has resulted in an increased outage rate per circuit. One of the methods being used to decrease the effect of these outages is the scheme of fuse and relay co-ordination. There are many variations of this scheme, but all have in common the idea of de-energizing the circuit when a fault occurs, allowing the fault arc to extinguish, then reclosing the circuit, and if the fault persists, blowing a fuse which de-energizes only the faulted section. On 3-phase 4-wire solidly grounded neutral systems lightning usually accounts for 60 to 80 per cent of the total circuit outages. With proper application of a co-ordinated fuse-relay scheme an average of 60 to 70 per cent successful reclosures can be expected. Some circuits have shown a short time average of 88 per cent successful reclosures, but this is considered exceptional.

The first requisite of the method of fuse and relay co-ordination is a thorough knowledge of the fault currents involved on the circuit to be protected. When these data are obtained, the relay equipment and settings desired can be ascertained. Minimum station relay equipment consists of three time delay relays, one per phase, for final equipment protection, one residual instantaneous overcurrent relay for initial tripping, and a recloser to reclose the station circuit breaker the desired number of times. The phase time delay relays should be of the very inverse variety. The instantaneous residual relay should have a very high drop-out characteristic, 90 per cent or better, to avoid pickup on unbalanced line recharging current. The recloser can be either one shot or multiple shot. Experience has shown that each reclosure after the first is progressively less likely to be successful, and indicates that very little is accomplished after the third reclosure. The phase time delay relays should be set so that their current-time curve does not exceed 75 per cent of the current-time curve of the equipment to be protected having the shortest current-time characteristic. The instantaneous residual relay must be set to trip the station circuit breaker for the minimum fault current expected, taking into consideration the fault impedance likely to be encountered. This relay should not be set low enough to trip on switching surges or lightning arrester discharges. It is recommended that the trip circuit of the residual relay be cascaded through a slug-type auxiliary relay to give a 2–3 cycle delay between the time the instantaneous relay contacts close until the circuit breaker trip coil is energized. Some circuits have shown a decrease in the number of circuit breaker operations as high as 40 per cent after such an auxiliary relay was installed.

After setting the station relay equipment the next step is to select a family of fuses that will co-ordinate among themselves and with the station relays. Recommended procedure is to plot on log-log paper the current-time curves of the time delay relays, the pickup value of the residual relay, the longest expected circuit breaker operating time, the longest permissible fuse time, and the line to be protected in terms of short-circuit current. This gives a "box" of limits inside which the fuses must operate, and an over-all view of the protected circuit. Plot the current-time curves of the fuse sizes desired on log-log paper to the same scale as that on which the station relay settings are drawn using 75 per cent melting time and 110 per cent clearing time and select sizes so that the 110 per cent clearing and 75 per cent melting curves do not overlap. By selecting families of fuses that fit inside the limits, a family of fuses which will co-ordinate with the relays is obtained.

For a particular point on the circuit one of the family of fuses is chosen which will operate within the limits established and which will co-ordinate with existing installations. If an entirely new circuit is being co-ordinated it is well to start with the smallest fuse size which will co-ordinate and work toward the station.

With the co-ordinated fuse-relay scheme of line protection, there are approximately 12 times the interruptions per customer as is experienced with a conventionally fused circuit. However, the interruption with this scheme is in the order of one second compared to an interruption of a half hour for the conventional method. This, combined with the fact that some 60 per cent, and in some instances as high as 88 per cent, of fuse replacements can be saved, indicates that, except for unusual cases, protection of distribution lines by the method of fuse-relay co-ordination can be recommended.

Report of the Protective Relay Engineers Conference; *Lewis M. Haupt, Jr. (Texas Agricultural and Mechanical College, College Station, Tex.).*

This paper covers a brief history of the organization of the conference, the content of the two conferences that have been held, the plans for the future, and the value of such conferences.

The Conference for Protective Relay Engineers is sponsored by the electrical engineering department, Agricultural and Mechanical College of Texas, College Station, Tex. The second annual conference was held March 14–16, 1949, on the campus of the college. Papers were presented by engineers representing manufacturing companies, consulting organizations, operating companies, and educational institutions. Following is a list of the papers presented:

"Load Frequency Control for Interconnected Power Systems" by R. E. Hansen, Leeds and Northrup Company

"Immediate Automatic Reclosing Without Pilot Relaying" by R. A. Larner, Texas Electric Service Company

"Operating Experience With Single-Pole Switching" by V. B. Wilfley, Westinghouse Electric Corporation

"High-Speed Relaying Practice" by L. F. Kennedy, General Electric Company

"Correlation of Product and Overcurrent Relays for Ground Fault Protection" by W. E. Douglass, Central Power and Light Company

"Distribution Line Protection Fuse and Relay Co-ordination" by J. P. Barron, Dallas Power and Light Company

"The Protection of the Plant Auxiliaries at the New Handley Steam Electric Station" by W. D. Jordan, Texas Electric Service Company

"Ground Impedances" by F. Von Voigtlander, The Commonwealth and Southern Corporation

"Preparation for a Short-Circuit Study on a Network Analyzer" by Peter White (deceased) and E. E. George, Ebasco Services, Inc.

"Limitations of A-C and D-C Network Calculators" by H. P. Peters, Georgia School of Technology

"A New Bus Differential Protective System" by R. E. Cordray, General Electric Company

"Novel Test Circuits for Protective Relaying" by W. K. Sonnemann, Westinghouse Electric Corporation

"Testing and Maintenance Schedules" by Charles L. Wilie, Jr., Texas Power and Light Company

"Recent Developments in Protective Relaying" by S. C. Leyland, Westinghouse Electric Corporation

This year's conference was attended by 108 engineers from 11 states.

Plans are being made for next year's conference which probably will be held in the Spring of 1950.

It is believed that such conferences are worth while in that they provide an opportunity for relay engineers associated with operating companies, manufacturing companies, and consulting organizations to confer with regard to their respective problems with mutual benefit.

Contribution of the Communication Companies to the Growth of the Southwest; *H. R. Fritz (Southwestern Bell Telephone Company, St. Louis, Mo.).*

To cover the contribution of all of the communication systems in the Southwest presents a task too formidable to be discharged adequately. Because of the large number of companies directly and indirectly engaged in providing communication service it has been impossible to accumulate data representing all of them. The discussion is restricted to those furnishing telephone and telegraph service for the public. Mention should be made in passing of the large contributions made to the progress of the Southwest by the many broadcasting companies directly serving the public, and the communication systems of the railroads, airways, pipe line companies, power companies, and others indirectly contributing to their progress.

Considering first the telephone companies serving the Southwest the contribution of the Bell System companies, particularly since the war, is summarized briefly. Data are given both for the South West as a whole, and separately for Texas in some instances since the Southwest District meeting was held in Texas and largely attended by Texans.

Total plant investment has increased from $514,000,000 near the end of the war to $862,000,000 at the end of 1948, an increase of 68 per cent. By the end of 1949 the total will be approximately $1,024,000,000, or an increase of practically 100 per cent since the war. By the end of 1949 the investment in Texas will have increased from 181,000,000 to about 420,000,000 during the same period, an increase of 131 per cent.

This large investment has resulted in the addition of 1,109,000 telephones in the whole territory since the war, an increase of about 53 per cent. In Texas there have been added 480,000 telephones, a growth of 63 per cent. By the end of 1949 these percentages are expected to be 69 and 88, respectively. The miles of toll circuit have increased from 1,300,000 to 2,300,000, a change of 79 per cent. For Texas alone the increase has been 91 per cent.

Activity has not been confined to the urban centers. Growth has been even more spectacular in rural areas, where there has been a 200 per cent increase of telephones for the Southwest and 340 per cent for Texas.

To serve the added telephones, 15.3 billion conductor feet of exchange cable have been installed. To house the nearly 2,000 switchboard positions added, the 704,000 lines of dial equipment installed, the large additions of toll central office equipment and to provide working space for the increased personnel, 133 additions have been made to existing buildings and 93 new buildings completed. Currently underway and to be started by the end of this year are some 100 additional building projects. Of these about 70 are in Texas.

Equally comprehensive data are not available for the 1,500 independent telephone companies serving this territory through 2,600 exchanges. These companies currently serve in excess of 760,000 subscribers representing an increase of 137,000 telephones since the end of the war. The investment in plant serving these subscribers and some 81,000 miles of toll wire must be many millions of dollars.

The application of ever-advancing techniques in record communication have been a factor in the rapid expansion of agriculture and industry in Texas and the Southwest. Wherever sudden increased activity has appeared, whether it is geographical market gardening, cattle raising, ship-building, or whatever, increased and improved record communication facilities have been quickly provided. In the broad term "record communication facilities" are included not only for telegraph message service but private wire networks and market quotation services.

Within the Southwest the Western Union Company recently has installed four automatic telegraph switching centers which give instantaneous direct service to a total of 11 such centers serving the rest of the nation. Through these centers located in Dallas, Kansas City, St. Louis, and New Orleans, message traffic is flashed to its destination without manual retransmission and at unprecedented speed. As a result of this advancement in technique, the Southwestern states already have a newer and finer telegraph service connecting them with the rest of the country.

To provide the network with the additional channels necessary for the operation of the new system, Western Union is using carrier systems which permit the transmission of as many as 288 telegrams simultaneously over a pair of wires. The telegraph company doubled the number of its carrier circuits in 1940 and now has 1,410,000 channel miles of carriers in operation. Of these a large portion are located within the boundaries of the Southwest and all are available to serve this territory.

Facsimile machines and teleprinter equipment are being placed at the disposal of more and more customers connected by direct wire with telegraph system to eliminate branch office relay and messenger delivery. Outstanding among these developments is the "Desk-Fax" a miniature facsimile machine which brings world-wide telegraph and cable communication within arm's reach of the user.

The Electrical Engineers' Contribution to the Growth of the Southwest; *G. R. Walton (United Gas Pipe Line Company, Houston, Tex.).*

The South and Southwest rapidly are emerging from their "colonial" status of supplying raw materials to the other parts of the nation. Although such agricultural items as cotton, grains, wool, and the like still are produced in large quantities, such diverse products as alcohols, nylon salt, acetone, formaldehyde, synthetic rubber, aluminum, and magnesium now are being produced in large quantities. This is attributed to the influx of heavy industry in which the electrical engineer plays such a vital part. Even the older industries are modernizing rapidly.

Saw mills, for instance, are one of the original industries of the Southwest. They now are spending much money on reforestration work, and adopting mechanical handling equipment for their products all the way from the trees in the forest to the lumber at the point of consumption. This in time will result in better working and living conditions for employees and will be reflected eventually in appearance and architecture of the mill towns and the mills themselves. Other impending changes in the saw-milling business is a wider use of waste products for making salable materials, which will necessitate electrification or other powering of the mills, direct heating of dry kilns, and the like.

The iron and steel business is getting started in the Southwest. The large mills at Daingerfield and Houston are pioneers, as are dozens of consumer goods plants making water heaters, heating equipment, welding rods, and the like.

The paper mills and an allied industry, the rayon mills, are looking up. Use of modern boiler house and electric generating and utilization equipment is progressing rapidly.

Contributions of the electrical engineer to the huge oil and gas business are too numerous to name. Some of the outstanding ones are the development of electrically driven high-pressure natural gas compressor stations for Texas Eastern Transmission Company, development of fully automatic pumping stations for crude oils and refined products, and the devising of control systems and measuring instruments which has permitted exactness of control and uniformity of product which never could have been achieved by the human hand and brain.

Large and looming larger on Southwestern horizons are the chemical plants of all kinds. Starting with native resources of salt, sulfur, a full line of acids, alkalies, fertilizers, and the like, are made. The area is fast becoming one of the leading sulfuric acid manufacturing centers of the world as well as a large producer of caustic soda and chlorine gas. These bring on the chemical fertilizer plants, glass plants, and now the light metal electrolytic plants. Mixing these chemicals with the various hydrocarbons abundant in the region, has produced a prolific petro-chemical business. In these plants such diverse items as formaldehyde, wood alcohol, antifreeze, plexiglas, acetic acid, drinking alcohol, and synthetic glycerine, to name but a few, are made in huge quantities. In all of these operations, the electrical engineer is a key figure, and these illustrations could be expanded many times. However, we would reach the same conclusion: in heavy industry, the electrical engineer is an important fellow in our midst.

The Economics of the Contribution of Electrical Manufacturers' Engineers to the Development of the Southwest; *W. J. Donald (National Electrical Manufacturers Association, New York, N. Y.).*

The principal economic considerations which influence the extent of the contribution made by the engineers of the electrical manufacturing industry toward the development of the Southwest are

1. The availability of an almost unlimited supply of very cheap fuel.
2. The vast distances.
3. The unusual location of some of the natural resources, such as oil deposits under the ocean floor.
4. In certain portions of the Southwest, the availability of water-borne transportation.
5. A salubrious climate.

Gas and petroleum pipe lines normally are made with welded steel plate using electric arc welders but the economic situation existing during the war determined that the

Big and Little Big Inch pipe lines should be made of seamless steel tubes.

The availability of proper electric welding equipment, both automatic and nonautomatic, contributes largely to the use of electric welding.

The booster compressors, or pumps, may be driven either by gas, or oil, engines, gas turbines, or electric motors. This depends on the economic value of the fuel at the location of each booster station.

The availability of outdoor automatic motor-driven booster stations indicates that they shall supplant attended gas or oil operated stations on account of the difference in labor cost.

In the petroleum industry generally, equipment must not only be dripproof but explosionproof, and the requirement in refineries for small blocks of power in individual drives makes the use of electric equipment almost mandatory.

The present trend is towards the use of electric oil well drilling rigs at oil wells over 10,000 feet.

The unattended automatic electric pumping station contributes greatly to low-cost operation wherever pumping is done, whether it be oil, water, or sulfur.

Steam and gas turbogenerating units contribute greatly to the efficiency of oil refineries in chemical operations because the gas turbine can operate on the waste gases of certain processes, while the steam turbine generating unit can supply low-pressure steam for various processes where the heat available from it is useful.

The principal contribution of electrical manufacturers' engineers to the chemical industry is the development of motors, control equipment, and wiring systems which will withstand various types of atmospheres encountered in chemical plants.

The production of sodium, chlorine, and magnesium is facilitated by the development of the ignitron rectifier to provide d-c power for electrolytic processes.

In agriculture and irrigation, the contribution of the manufacturers has been significant in the development of suitable motors and control for pumping equipment and also equipment for electric curing and drying of hay, and other agricultural products, and the development of limited input farm welders.

The development of dripproof and moisture-resisting electric equipment for use in paper mills and particularly the control for the paper mill drive combined with the availability of cheap power and the rapid growing southern pine trees makes the southwestern pulp and paper industry the thriving industry that it is.

In the mining industry, surface and underground electric haulage locomotives, the mining belt conveyor, and the electric motors and control equipment for both mining hoists and stripping shovels constitute the electrical manufacturers' contribution to that industry.

In the central station industry, the availability of efficient steam and gas turbogenerating units and transmission and distribution equipment to meet the various demands of the Southwest represent an important element in the progress of that industry. Some of the problems which confront the central station industry and which have been met with the assistance of the electrical manufacturers' engineers are tremendous rise in the use of electricity in different areas, the great range in altitude and in climate, the opportunity for outdoor installations, and the unusual atmospheres encountered by the products serving such diverse industries as chemical, paper, and petroleum.

Preliminary Studies for the 300-Million-Electron-Volt Synchrotron at the Massachusetts Institute of Technology;*

J. E. Thomas, Jr. (*Laboratory for Nuclear Science and Engineering, Massachusetts Institute of Technology, Cambridge, Mass.*).

Of all charged particle accelerators, the highest output energy for a given weight machine can be obtained with the synchrotron.

In a synchrotron charged particles, magnetically guided in constant radius circular orbits, pass repeatedly between radio-frequency electrodes. The orbit rotation of the particles is self-synchronous with the radio frequency. The Massachusetts Institute of Technology machine is designed to have orbit radius 1.0 meter. Electrons will pass 200,000 times through approximately 1,500-volt drop to achieve final energy 300 million electron volts. The magnetic guide field only need cover a ring-shaped region; nevertheless, the 300-million-electron-volt machine requires a 55-ton laminated silicon steel magnet.

Past practice in design of betatron and cyclotron magnets has been to follow the general shape of a 3-leg transformer, with the gap in the middle leg. The present design is a symmetrical circular arrangement of 24 "C" shaped sections with gap inside and return path outside. Maximum possible economy in the use of magnet steel thus is attained.

The mechanical construction of the magnet is similar to that found in high-power transformers. Accordingly, the Allis-Chalmers Manufacturing Company was called on for design and fabrication of the parts.

The space distribution of the magnetic field and its time variation must be controlled carefully lest the electrons be lost before reaching peak energy. For example, a phase difference of one microsecond between the magnetic field at two points in the gap can cause serious trouble. It has been necessary to add to the magnet a number of auxiliary windings in the gap and around various portions of the magnetic circuit. Correct choice of magnitude and phase of the currents in these windings has reduced the magnetic field deviations to a tolerable level.

The discharge of an 800-microfarad capacitor at 15 kv supplies the main winding current for the magnet. Capacitor and magnet resonate at 60 cycles but through ignitron control only one cycle of oscillation is allowed every one-sixth second. As the duty cycle is low, considerable economy was possible in the construction of the ignitron and capacitor banks. These components were designed and built by the General Electric Company.

The high-vacuum doughnut in which the electrons circulate must be nonmetallic yet have better mechanical properties than ordinary glass. As the doughnut wall can be used effectively as part of the radio-frequency system, it is desirable that it be of a low-loss high-dielectric constant material. A special ceramic has been developed at the Massachusetts Institute of Technology for this purpose. Its rupture modulus is 17,000 pounds per square inch, dielectric constant 9.0, and loss tangent 0.001 at 45 megacycles.

The Application of C^{14} in Biological and Medical Research;

Wright H. Langham (*Los Alamos Scientific Laboratory, University of California, Los Alamos, N. Mex.*).

Carbon^{14} was one of the more promising radioactive isotopes to be made available as a result of the atomic energy development program. As carbon is a major constituent of all biological systems its potential applications to biological and medical studies are almost unlimited. A number of major difficulties, however, complicate its use by the average biological or medical investigator. Among these complicating factors are

1. The difficulty of synthetizing the isotopic carbon into organic compounds having biological or medical significance.
2. C^{14} emits an extremely weak beta radiation (0.15 million electron volts) which complicates considerably the technics for quantitative measurement.
3. The use and manipulation of the labelled compounds requires the development of special technics and the development of special problems in biology and medicine to which the radioactive tracer method is uniquely suited.

The members of the biomedical group of the Los Alamos Scientific Laboratory have developed special micro methods of synthesizing a number of biologically significant compounds labelled with C^{14}. Among the labelled compounds that have been synthesized are urea, nicotinic acid (the anti-pellagra vitamin), nicotinamide, *p*-aminobenzoic acid (another of the vitamin series), pentobarbitol (a prominent sedative), and methyl nitrogen mustard (a substance now being used in the treatment of certain types of lymphatic cancers).

Technics have been developed for the use of these labelled materials in animals for the purpose of making fundamental biological and medical investigations. Using the tracer method and radioactive urea, it has been discovered that the mouse gives out approximately 20 per cent of the radioactive carbon as carbon dioxide in the expired air. Using the method of radiochromatography, it has been discovered that there are five radioactive metabolic products of pentobarbitol and five radioactive metabolic products of nicotinic acid excreted in the urine of the mouse following intraperitoneal injection of the labelled compounds. Some of these excretory products have been identified. Using C^{14} labelled nicotinic acid and nicotinamide, it has been demonstrated that human red blood cells can utilize the nicotinic acid but not the latter compound. When given in vivo, however, nicotinamide is used by the red blood cell presumably by being first converted to nicotinic acid in the liver. It has been demonstrated also that the function of these substances in the medium of yeast cells and red blood cells is to produce Coenzyme I.

Methods of quantitating C^{14} activity in biological systems have been developed and applied, thereby providing information as to how this very important isotope may be used in further investigations of biological and physiological processes.

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* Assisted by the joint program of the Office of Naval Research and the Atomic Energy Commission.

Out of the Texas Woods for News; *I. T. Hockaday* (*General Electric Company, Schenectady, N. Y.*).

The Chinese were making pulp and paper from bamboo back in 150 B.C. They got their idea from the hornets and wasps who were the first real paper-makers. They gathered the fibers, chewed them up to a mushy substance, wove them into a nest, and let them dry. So the Chinese, seeing the high quality of paper-like substance made by these insects, developed the process somewhat for themselves.

It took almost 1,800 years for the art of paper-making in China to reach the United States. In 1690 this country had a total paper mill capacity of about 250 pounds per day. In 1939 the paper-making capacity in the United States was 140,000,000 pounds per day. Most of the newsprint paper up until a few years ago was made from Northern spruce. However, Dr. Charles Herty of Savannah, Ga., conceived the idea of making newsprint from Southern pine and developed the process to a satisfactory state in his laboratory and this laboratory development was developed into a commercial product through the courage, initiative, and indomitable will of Ernest L. Kurth of Lufkin, Tex., who pioneered in building a newsprint mill in Lufkin in the East Texas pine belt to manufacture newsprint from Southern pine. The first unit of the Southland Paper Mills was built in 1939 with additions in 1944 and 1948. A day's run from one paper machine produces a sheet of paper 18 feet wide by 1,500,000 feet long.

The logs that are cut in the forest, as well as salt cake and other materials, are hauled into the mill by diesel-electric locomotives. The daily requirements for these raw materials approximate 600 cords of wood and 20 tons of salt cake. The logs are cut to correct length and delivered to the debarking and chipping machines, and on to the grinding, cooking, mixing, and washing machinery, all of which are driven by a-c motors. The pulp, after further refining processes, is delivered to the paper machines themselves; first to the fast traveling screen wire (fourdrinier), where some water is drained off, then to the rolls, presses, driers, calenders, and, finally, the reel—all of which takes place at speeds ranging from 1,200 to 1,800 feet per minute. Each section, that is the fourdrinier or wire, rolls, presses, driers, calenders, is driven by individual electric motors which are controlled so that speeds between various sections can be varied to keep tension, draw, and loops in their proper relation and at the same time keep breaks to an absolute minimum.

Large quantities of water are required also and a daily supply of 16,000,000 gallons is pumped from deep wells and forced through an 8-mile pipe line to the mill.

All of these processes require hundreds of motors, transformers, switchgear, and so forth. Four thousand horsepower synchronous motors at 6,900 volts are used for driving the grinders. Electric power is produced by double automatic condensing steam turbogenerators totalling 32,000 kw. The extracted steam is used for heating, drying, and cooking processes, and a close balance between steam and electric requirements is obtained.

Experience With Insulating Oils From the Utilities Viewpoint; *D. D. Clarke* (*Kansas City Power and Light Company*).

Utilities in the United States have in use some 100 million gallons of insulating oil. The equipment that this oil insulates is worth a third of a billion dollars. Insulating oil has a really tremendous over-all responsibility.

Technically oil is a very complex substance and about all the utility engineer ordinarily knows about it is on a basis of experience with this or that oil as offered by the several suppliers, together with a comparison of its performance when used in several types of equipment.

Pole-mounted distribution transformers probably account for one-fifth to one-fourth of the insulating oil in actual use. Other than for good housekeeping and pride of workmanship, there is no problem and practically no expense involved in upkeep of the oil.

Transformers that supply the power to industry are of more concern. The size is larger and there is a definite tendency to forget all about them as the individual users' power demand gradually is increased. These transformers often run hot and give trouble. There are comparatively few cases of trouble from the oil, however. The older transformers freely breathe air into the space above the oil and, sometimes, the oil is so acid it stinks but it does not quit. Almost all failures of such transformers are a direct result of overload or of accident. Of course, again, sludge in the coil ventilating spaces may be a contributing cause of insulation failure.

Utility substation transformers individually supply a large number of customers and continued service is of utmost importance. Insulating oil is watched. Periodic tests are compared with previous record and any tendency to slip is checked up on immediately. Except on older equipment very little air can come in contact with the oil. Overloads are known and renovation is anticipated.

Probably the toughest job insulating oil has to do is in oil circuit breakers. It is in free contact with the air and so has every opportunity to oxidize. Where the duty is heavy on the circuit breaker, the oil carbonizes—gets full of floating black soot that is conducting in nature and coats insulating surfaces—sometimes causing failures. Where oil is tested periodically, the usual test shows bad, say below 20,000 volts on dielectric test.

Utilities have been fortunate in that manufacturers of transformers for many years have regarded the insulating oil as an item of transformer design. The failure of any part of a transformer within the guarantee period is the manufacturer's responsibility. Any apparent failure at any time is subject to service by the manufacturer. In this way a co-operative design information service has been in effect for many years and equipment gradually has improved in balance of design, as well as in economy of production. The specific type of oil furnished or advised for replacement is best suited to over-all performance.

From the consideration of good oil performance, it is fortunate that hot spots in the transformers are to be avoided in good design. Oil, like most other chemical reactions, breaks down faster at higher temperatures. The speed of reaction doubles with each ten degrees centigrade increase in temperature. The hottest spot determines the life of the oil as well as the life of other ordinary insulation. Modern transformers have comparatively uniform temperature throughout their winding, and thus inherently extend the life of the oil. However, good design does not prevent overloading transformers in operation. Overloads mean higher temperatures and damage by shortened life of both the insulation and the oil.

Large transformers that are used in utility substations involve an investment that permits insurance and deserves consideration of extended life through special consideration of every feature of design. Oil is no exception. Any contact with either water or the oxygen of the air shortens the useful life of the oil and eventually may derate the capability of the whole installation. Several types of tank assembly are offered especially to protect the oil and through this protection insure the continued service of the transformer.

There are a number of tests used on transformer oil and each, of course, has its peculiar merits. The oldest and still the most usual test is the dielectric test with a standardized cup and one inch disks separated one-tenth inch. Oil that tests above 20,000 volts is considered serviceable. The range is from about 10,000 volts to 40,000 volts. This test, together with inspection in a clear glass bottle, usually is depended on for check procedure. In cases of actual trouble, other tests such as for neutralization number may be a guide to possible causes. The sulfur was found by chemical analysis.

Filter press treatment for transformer oil is not as fast as some of the other treatments. It is, however, the most usual treatment.

Vacuum and filter treatment is used for 66-kv cable oil on the recommendation of the cable manufacturers. This provides thorough degasification that is essential in a specific type of equipment. To take full advantage of this method, the oil must not come in contact with air after treatment. It is believed that this extreme care is necessary only on extra-high-voltage and specialized equipment.

Chemical treatment with strong sulfuric acid has been used by utilities but generally is frowned upon by the safety group. This and other chemical treatments, it is believed, should remain properly with the oil industry.

From the utility viewpoint, the use of insulating oil is properly an economic proposition. If oil-insulated transformers are less costly to operate, they are used instead of Askerol, or of dry type. If oil circuit breakers are less costly to operate, they are used instead of air type. Likewise, the cost of maintaining the oil is part of the cost of operating the equipment in which it is used and all such costs must be kept to an over-all minimum. The extensive use of insulating oil and the great effort that has been, and is being, made for its proper care indicate that it is an economic insulating medium.

INSTITUTE ACTIVITIES

The Friendships of Our Institute

—*A Message From the President*

The electrical engineers at Richland, Wash., who had been granted Section status by our Board of Directors asked me if I would be present at their inaugural meeting on my way to the Pacific General Meeting of our Institute at Spokane last August. This, I told them, I would be delighted to do. Richland is our 82d Section.

There were some 80 signers of the petition for Section status and thus I thought there would be some 60 or 70 engineers at the meeting, but when I arrived at the American Legion Hall in Richland for the meeting I found 168 present—practically all of the 80 signers were there and each had brought his wife, and there were some others. I hastily gathered that my talk would have to be different than I had planned, and as I entered the hall, up stepped a man who grasped my hand and said, "Mr. Lee, I am Frank Wilson, I remember when you talked to us in Charleston, W. Va., in 1943." And immediately there was a young man who said, "Mr. Lee, I am Mr. Staples; I remember when you talked to us in Muscle Shoals in 1938," and then another young man who said, "I am Mr. Krazel and I was with Mr. Wilson when you were with us in Charleston." There also was my friend Dean Johnson who had been on our Board of Directors with me and who now was directing the entire educational activities at that great Hanford Project, and there were others of my friends whom I had known previously, and then it flashed to my mind that I would speak to that great inaugural meeting on "The Friendships of Our Institute." This I did, for I could tell the group that the friendships of our Institute were another of its great strengths, and that many in that room were there because of friendships formed in their engineering life just as everywhere throughout our Institute there are abiding friendships among the engineers to make life happy, and helpful, and full of service. Our Institute provides the opportunities for the formation and the cultivation of these friendships; and they are abiding.

As I have had opportunity since to visit the Sections and the Subsections and the Student Branches of our Institute, I have told this story, and I have found friendships everywhere; abiding friendships for great good. I have found them to be one of our great strengths, and I have urged the Student Members in our Student Branches to cultivate friendships, and have pointed out to them that in our Institute they will find a rich opportunity for friendships, and that as they live on in their Institute lives they will find the friendships they have made to be the foundation of the happinesses and the opportunities that will come to them.

Nor are these friendships confined to our Institute, for they extend to our brother engineering societies, to the civil engineers, to the mechanical engineers, to the chemical engineers, to the mining and metallurgical engineers, to the radio engineers, to the illuminating engineers, to the electrochemical engineers, to the consulting engineers, to the professional engineers, to the engineering educators, and to all engineers in all of the many other strong, virile, active engineering societies of our land, and to other lands. The daily lives of engineers everywhere move in ever-widening channels to come into intimate contact in a multitude of ways with members everywhere of the great engineering profession, where again engineering friendships play a most potent part in the strength, happiness, and sincerity I have found everywhere among the engineers, particularly among the electrical engineers as I have been visiting them, and extending likewise to all others as I have been privileged to meet with them and to talk with them.

Not that we do not have our problems—I find them everywhere—but they are not serious and I find everywhere engineers who are leaders who have analyzed the particular situations to establish their elements and to move in on these with an understanding of fundamentals to bring about a result of great good, just as engineers are so capable of doing if they only will give the necessary time to the progression of these projects to their establishment.

Now, all the things that all men have, come from the engineer, and all the services which men enjoy have come from the engineer, thus engineers are everywhere in there pitching, day-in and day-out, to bring newly into being, and to continue to improve in being, all the products for the service and enjoyment of the people and all the services so needful to their daily living. This is the common bond of the engineer everywhere. And as these products and services cover the universe in a multitude of kinds and varieties, so the engineering friendships which the engineer has formed in these many fields have resulted in many groups; we call them engineering societies, and they, as characteristic of engineers, have great strength and they have each produced a useful result, a result for great good. They all have as their basis service and friendship, and there is no firmer basis.

This is what makes the engineering profession great, and what makes the engineer to be respected in his community where he is known. He makes himself known by the individual service which he renders to his fellowmen in his community life where again friendships are formed beyond his engineering life into his general life—and for great good, for not only is he as an individual recognized, but when it is known that he is an engineer, there comes the recognition to the profession which he brings as an individual engineer. As this participation is broad by all engineers, so will the profession be characterized by the attributes which have made it great in its own right.

Some engineers are not happy with the multitude of engineering societies which have come about through what I think are natural causes and to be thus of great strength. I am not one of these. I see in what some call "the fragmentation of the engineering profession" rather the natural result of the friendships and the services in the multitude of fields of endeavor served by the engineer to produce the many strong, virile, active engineering societies that we have, each serving its purpose manfully, and each with such understanding of the others again through friendships, that when there is definite need for a combining of interests for some need to the engineers concerned themselves, they can unite appropriately for the specific purpose to be accomplished, to accomplish it, and then continue along until there may be need again for such course of action. This preserves the independence and the strength of each group for all of the manifold operations within the group, and brings these independent strengths to bear when there is a dependence sufficient for co-ordinate action to advantage. I believe that the fundamental position of the engineer himself has dictated this position. Surely throughout all the years with all of the efforts to prevail against it there has been no success.

There has been no success in this direction not because of the weakness of the engineering profession, but rather because of its strategic position fundamentally in the lives of mankind, and because of its great strength in the fundamentals of service and friendships. These are predominantly on a group basis. The contact of the individual engineer in his profession with the public is in a relatively small proportion. This lack thus must be made up by individual participation of the engineers in civic services, and it is being so done by many many engineers. The pity is that it is not understood by more engineers that they too will avail themselves of the opportunity additionally to serve and to establish even wider friendships where they will find that fuller recognition which those who do not recognize the situation crave, but which those who progress it find therein augmented pleasure, with recognition following in measure appropriate to the service rendered.

Our Institute established by friendships gives the opportunity for the extending of friendships. These are our great strength. These are the strength of the engineering profession.

Membership Views Sought on Institute Policy

The AIEE Board of Directors desires to obtain the opinion of the membership on a general question which affects some of the long-term policies of the Institute. With a better understanding of the wishes of the membership, the Board's decisions on many matters which come before it can be made with more assurance that the Directors are carrying out the desires of the membership.

At the Dallas meeting of the Board of Directors, several hours were devoted to discussion of Board action on general policy. To stimulate discussion Walter Smith offered the following resolution for study:

> The Board of Directors, recognizing the equivocal position in which it is now placed, particularly in the eyes of our younger members, because of the fact that it is attempting, in a small way, with inadequate funds and personnel, to concern itself with some of the nontechnical activities of these members, and with a realization that such interests may much more efficiently be taken care of through another organization set up for that purpose, and recognizing the present difficulties of dealing with controversial matters, with consequent loss of prestige and possible splits in our membership, and recognizing the overwhelming importance of promoting in every possible way the technical interests of our members, hereby declares that the American Institute of Electrical Engineers is strictly a scientific and educational organization, and that, in conformity with this declaration, it will be the policy of the Board of Directors to promote in every way the technical interests of our members to the exclusion of any other interests; also, that, where the Institute or any of its Sections is a joint member in another organization, it will be the policy of the Institute to interest itself in only such joint matters as relate to the technical activities of its members.

While there was no lack of personal opinion on the part of Board members, no member felt sure that he reflected accurately the opinions of the membership. The following action was taken:

> Voted that the resolution be received, and the matter presented be referred to a special committee whose assignment shall be to stimulate discussion and consideration of this subject, both in the next meeting of the Section Delegates and in the Sections; and that, based upon such considerations, the committee shall report to the Board of Directors not later than the time of the Board meeting at the 1950 Winter General Meeting, with a progress report at each Board meeting in the meantime.

President Lee then appointed Board members M. D. Hooven (Chairman), J. L. Callahan, and R. T. Henry as a special committee and they, in turn, have made arrangements with the Sections Committee for discussion at the June meeting of Section Delegates. Discussion at the Board meeting brought out many areas of complete agreement; variation appeared in attempts to consolidate previously pursued policies into a more consistent pattern.

The present excellent reputation of the Institute in the technical field is based on many years of close attention to its technical activities. Therein lies the fundamental interest of Institute membership. The question becomes how much, if any, of the time of its administration and membership should be utilized in the field of so-called professional activity, and how much would the membership be willing to pay for real work in that field? Or, what proportion of the Institute membership have any real interest in that field? Generally accepted thoughtful opinion is that the engineer should devote more of his time to citizenship responsibilities* and to professional responsibilities. In fields such as these however the Institute, as an assembly of electrical engineers, cannot work alone. It must work with other societies or its members who are interested in this field must work through some separate channel such as an autonomous society devoted to the pursuit of these activities. The Institute is and has been working with other groups through Engineers Joint Council and Engineers Council for Professional Development.

Engineers Joint Council consists of past presidents, secretaries, and alternate representation of the four Founder Societies and the American Institute of Chemical Engineers. Under its newly adopted constitution, it is capable of enlargement with reasonable facility and each of its constituents can support or refuse to support any project the Council undertakes. It plans to enter into greater activity on joint projects. Its committees are

Executive Committee
Constitution and Bylaws
Collective Bargaining
Unity of the Engineering Profession
National Engineers Committee
Consultive to Federal Authorities
Science Legislation Panel
Cancer Research Committee
Selective Service
Committee on International Relations
Committee of Secretaries
Committee on National Water Policy
General Survey Committee
Committee on Fuel Resources
United Nations Educational Scientific and Cultural Organization

Under the Smith resolution several items of activity would not be supported by AIEE.

Engineers Council for Professional Development is composed of representatives from the four Founder Societies and American Institute of Chemical Engineers and from the American Society for Engineering Education, the National Council of State Boards of Engineering Examiners, and the Engineering Institute of Canada. Its committees are

Student Selection and Guidance
Engineering Schools
Professional Training
Professional Recognition
Information
Ways and Means
Engineering Ethics

In general these activities are educational. Most would be supported by AIEE.

Local engineering councils are participated in by a large number of Sections. Over a long period of years the Institute has fostered such Section participation. The adoption of the Smith resolution would tend to restrict some official AIEE participation.

The Professional Activities Subcommittee in the May 1947 issue of *Electrical Engineering* (*pp 496–501*) published the results of several years of work and survey on its subject. In general, the membership preferred an over-all engineering society with a separate division handling professional activities and AIEE in effect becoming a technical division of such a society. The preferred plan was "to provide an over-all engineering organization of the individual membership type with continuation of affiliated societies for specialized technical purposes only; and so forth."

Past President Hull, during his administration, made the theme of his talks to the Sections the desirability of organizing this over-all engineering society. He still hopes that EJC's Committee on Unity will bring forth a plan for a convocation of national engineering societies on the subject of unification and that this will take place soon.

The Institute's work in nontechnical fields is not followed with the same assurance or expedition as that in the purely electrical engineering field. Compromises, give and take, adjustments with other societies, are the order of the day. Inconsistencies of action within the Institute are unavoidable.

Having in mind after nearly 30 years of trial and observation, the delays and difficulties of such joint undertakings by autonomous societies, many members of the Board of Directors, and, it is believed, many members of the Institute, believe that the Institute could confine its activities advantageously to "the advancement of the art and science of electrical engineering" and that the problems common to all engineers regardless of their branch of specialized interest could be pursued more advantageously through a separate organization.

Mr. Smith's resolution would cut the Gordian knot. However, it would not free the individual member of his citizenship and professional responsibility. His obligation to work through his professional engineer's society, or an eventual over-all engineering society, would become greater.

The question is, what do the members want? The action of the Board of Directors at the Dallas meeting is intended to set in process a study through which it is hoped to obtain a clearer picture of the desires and opinions of the membership.

Future AIEE Meetings

Summer General Meeting
New Ocean House, Swampscott, Mass.
June 20–24, 1949
(*Final date for submitting papers—closed*)

Pacific General Meeting
Fairmont Hotel, San Francisco, Calif.
August 23–26, 1949
(*Final date for submitting papers—closed*)

Midwest General Meeting
Netherland Plaza Hotel, Cincinnati, Ohio
October 17–21, 1949
(*Final date for submitting papers—July 19*)

Winter General Meeting
New York, N. Y.
January 30–February 3, 1950
(*Final date for submitting papers—November 1*)

North Eastern District Meeting
Providence, R. I.
April 26–28, 1950
(*Final date for submitting papers—January 26, 1950*)

Great Lakes District Meeting
Jackson, Mich.
May 11–12, 1950
(*Final date for submitting papers—February 10, 1950*)

Summer General Meeting
Pasadena, Calif.
June 12–16, 1950
(*Final date for submitting papers—March 14, 1950*)

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* See "The Professional Estate" by Charles E. Wilson, an address presented at the 1949 Winter General Meeting in New York, N. Y., (*EE, Mar '49, page 187–90*).

Summer Meeting in Swampscott Will Feature Broad Technical Program

The 1949 AIEE Summer General Meeting, which will be held in Swampscott, Mass., June 20–24, will provide a technical program of broad interest, with opportunity for inspection trips, sports, and social recreation. Swampscott, on Boston's north shore, affords unlimited opportunity for healthful outdoor enjoyment. It is located at the center of the great historical and educational background of New England. The New Ocean House, meeting headquarters, is located right on the Atlantic Ocean, and has a private beach, extensive grounds, and an excellent 1,000-yard golf course. Points of historical interest, such as Lexington, Concord, Marblehead, Salem, Gloucester, Plymouth, Cambridge, and "White Court," formerly the summer home of President Coolidge, contribute toward making Swampscott a location of outstanding interest.

REGISTRATION FEES REQUIRED

Members and nonmembers should register for the meeting in advance by filling in the advance registration card included with the mailed announcement. In accordance with the policy as set up by the AIEE Board of Directors, a registration fee of $3 will be required for members and a fee of $5 for nonmembers. This is to help make the meeting self-supporting and obviate the need for raising the annual dues. Student Members and immediate families of members will not be required to pay any fee.

ENTERTAINMENT AND BANQUET

On Monday evening there will be informal dancing in the ballroom, for the purpose of getting acquainted with the various members and establishing friendships, while on Tuesday evening an old-fashioned barn dance will be held in true New England style, literally and figuratively. In fact, this will be the chance of a lifetime for many members to find out what a barn actually looks like. Costumes will add much to the occasion and they may be simple or elaborate as desired, with the understanding that reward is its own merit and prizes for costumes certainly will be awarded. In true New England tradition, music will be furnished by the Wayside Inn Early American Dance Orchestra.

There will be souvenir dance programs for the ladies, ample instruction in old-style dancing, and in general a complete, full, and satisfying New England evening.

On Wednesday evening the President's Reception will take place in the ballroom. The banquet will be held in the main dining room at which the featured speaker will be President Killian of the Massachusetts Institute of Technology. The cost will be $4.75 per person, and reservations may be made at the registration desk.

Thursday evening will feature informal dancing which will include one hour of typical New England entertainment by a special novelty orchestra as definitely New England as is the one for the barn dance.

SPORTS

The annual competitions for the Mershon golf and tennis trophies will be held during the week of the meeting. In addition, nearby country clubs will be available for individual play. Adjacent to the headquarters hotel, facilities for horseshoe pitching, bowling, table tennis, and a "pitch and putt" golf course will be arranged. If individuals are interested in sailing or motor boating, the committee will help make arrangements for the chartering of boats from local yards.

LADIES' ENTERTAINMENT

The following entertainment has been arranged for the ladies attending.

Monday, June 20

3–5 p.m. Get-acquainted tea

Tuesday, June 21

9 a.m.–12:45 p.m. Conducted tour of historic Salem and Marblehead

2:30–6:00 p.m. Inspection trip to *WBZ* television station, Allston, Mass.

Wednesday, June 22

2:30 p.m. Handwriting analyst—bridge and prizes

Thursday, June 23

10:00 a.m. Book review

1:30–6:00 p.m. Conducted tour of North Shore and Gloucester

Friday, June 24

Special conducted tours as requested

From Monday through Friday, special adjoining meeting rooms will be available for the use of the ladies, for cards, special entertainment, and so on.

Arrangements for sports, such as golf and tennis, will be made for those interested.

Note: A nominal charge of $1 will be made for each trip involving transportation.

INSPECTION TRIPS

Inspection trips to the following places have been arranged. Others will be announced at the meeting.

1. Boston Naval Shipyard. One of the Navy's oldest yards. A rope walk and anchor factory are among the many interesting things to be shown. The historical *Old Ironsides* is one of the first. This trip is on Monday, June 20, 9:30 a.m.

2. Massachusetts Institute of Technology and Harvard University. The activities of these two institutions are world-famous. The inspection trip will include radar laboratories, computation laboratories, nuclear research facilities, museums, and several other places on the campuses. This trip is on Tuesday, June 21, 9:30 a.m.

3. *WBZ* Television. One of Boston's largest and most modern television stations, the studio as well as the broadcasting facilities will be visited. This trip is on Tuesday, June 21, 1:30 p.m.

4. Lynn Telephone Exchange. The working of a modern crossbar telephone exchange will be shown. This trip is on Wednesday, June 22, 1:30 p.m.

5. The Mystic Station Boston Edison Company. The Mystic Station has about three large generators, two of 57,500 kva and one of 71,875 kva. The distribution system includes two 110,000-volt transformer equipments which are for changing under loads. This trip will include inspection of these facilities. This trip is on Thursday, June 23, 9:30 a.m.

6. The General Electric Company. This trip will include visits to both Lynn Plant Divisions of the company, which will include meters, instruments, motors, aircraft gas turbines, lighting and rectifier, and turbines. This trip is on Thursday, June 23, 1:30 p.m.

7. Excursion boat trip around historical Marblehead Harbor will be available to those desiring it.

HOTEL ACCOMMODATIONS

Special AIEE meeting rates at the New Ocean House, including room and meals, will be as follows (rates are daily, per person):

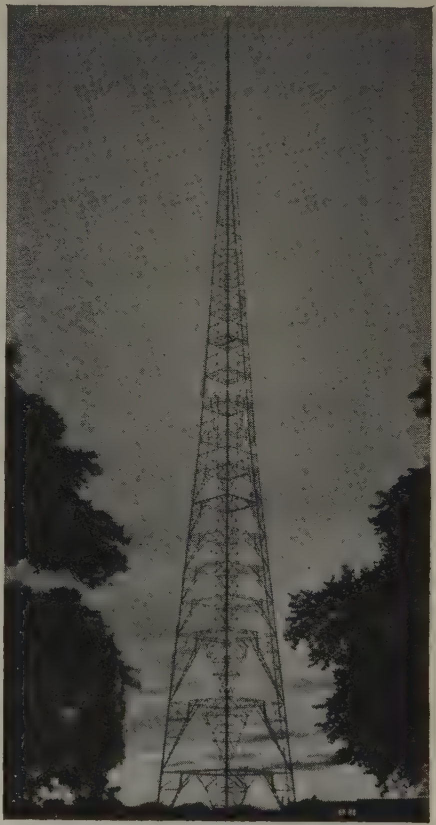
Double room with bath, twin beds	$ 9.50 and	$10.00
Double room with bath, twin beds, ocean front		10.50
Large room with bath, three beds	8.75 and	9.00
Large room with bath, four beds	8.50 and	8.75
Double room with running water, twin beds	8.75 and	9.00
Suite, 2 double rooms, bath between, four beds	9.00 and	9.50
Suite, 2 double rooms, bath between, six beds	8.50 and	8.75
Choice corner or bay window room with bath, twin beds	11.00 and	12.00
Single room with bath	12.00 and	13.00

Members should make their plans early. A hotel reservation card has been enclosed with the meeting announcement.

STUDENT ACTIVITIES

Student Members of the AIEE are extended a cordial welcome to attend the Summer General Meeting in Swampscott, and a special room will be set aside where students may gather throughout the meeting. All meetings, inspection trips, and social affairs are open to Student Members. Of particular interest will be the inspection trip to Massachusetts Institute of Technology where all laboratories will be open.

Friday, June 24, will be a full day of



New England's tallest structure is now the WBZ television and frequency modulation antenna. The 649-tower is located at the rear of the new WBZ Radio and Television Center on Soldiers Field Road, Boston, Mass., and is convenient for inspection by visitors to the AIEE Summer General Meeting to be held in nearby Swampscott, Mass., during the week June 20-24, 1949

Tentative Technical Program

Summer General Meeting, Swampscott, Mass. June 20-24, 1949

Monday, June 20

9:30 a.m. Switchgear

49-128. Field Tests of Oil Circuit Recloser Substantiate Analytical Co-ordination Method. *G. G. Auer, R. A. Branflick, L. J. Woodward*, General Electric Company; *W. C. McKinley*, Central Electric Cooperative, Inc.

CP. Metalclad Switchgear Manufacture, Test, and Inspection.** *B. I. Hayford*, Westinghouse Electric Corporation

CP. Selective Tripping of Low-Voltage Air Circuit Breakers for Power Station Auxiliaries.** *J. M. Geiger, L. L. Fountain*, Westinghouse Electric Corporation

CP. Guide for the Application of Low-Voltage Air Circuit Breakers.** *Committee Report*

9:30 a.m. Electric Welding

CP. Arc Metal Transfer Analyzer.** *R. C. McMaster, D. C. Martin, A. Leatherman*, Battelle Memorial Institute

49-129–ACO.* Characteristics of Arcs Between Moving Electrodes. *W. B. Kouwenhoven, T. B. Jones*, The Johns Hopkins University

CP. Operational Timing Pattern for Electronic Resistance Welding Control.** *H. B. Hills*, General Electric Company

CP. Electrical Advantages of Low-Frequency Welding Converters.** *C. B. Stadum*, Westinghouse Electric Corporation

9:30 a.m. ECPD Accrediting of Electrical Engineering Curricula

CP. ECPD Accrediting Program.** *D. E. Prentice*, President Emeritus, Rose Polytechnic Institute, and Past Chairman, ECPD Committee on Engineering Schools

CP. What the Accrediting Visitor Sees.** *E. L. Moreland*, Executive Vice-President, Massachusetts Institute of Technology, and senior partner, Jackson and Moreland, Engineers

9:30 a.m. Instruments and Measurements

49-130. The Measurement of Dielectric Loss at High Frequencies and Under Changing Temperatures. *J. B. Whitehead, W. Rueggeberg*, The Johns Hopkins University

49-131. Instrumentation for the Evaluation of the Stability of the Welding Arc. *Lauriston P. Winsor, L. McDonald Schetky, Robert A. Wyant*, Rensselaer Polytechnic Institute

49-132. A Wide-Band D-C Amplifier Stabilized for Gain and for Zero. *A. J. Williams, Jr., W. G. Amey, W. McAdam*, Leeds and Northrup Company

CP. Unusual Applications of the Cathode-Ray Oscillograph in the Electrical Industry.** *P. S. Christaldi, W. J. Fockler*, Allen B. Du Mont Laboratories, Inc.

2:00 p.m. Insulated Conductors

49-133. Transformer Manholes and Vaults—Design and Ventilation. *L. F. Porter*, Consolidated Edison Company of New York, Inc.

49-134. The Temperature Rise of Cables in a Duct Bank. *J. H. Neher*, Philadelphia Electric Company

49-135. A-C Resistance of Segmental Cables in Steel Pipe. *L. Meyerhoff, G. S. Eager, Jr.*, General Cable Corporation

49-136. 69-Kv Pipe-Type Cable Circuits in Philadelphia. *A. H. Kidder, G. S. Van Antwerp*, Philadelphia Electric Company

49-137–ACO.* Observations on Recent Developments and the Trends in High-Voltage Cable Transmission. *P. H. Chase*, Philadelphia Electric Company

2:00 p.m. Industrial Control and Servomechanisms

49-138. Dynamic Braking Control of D-C Series Motors—Experimental Study of Speed-Torque Curves. *G. W. Heumann*, General Electric Company

49-199. A Wide-Range Adjustable Speed Drive. *A. G. Conrad, E. R. Tribken*, Yale University

49-197. Instrument Inaccuracies in Feedback Control Systems With Particular Reference to Backlash. *H. T. Marcy, Morris Yachter, Jerome Zauderer*, The M. W. Kellogg Company

49-196. Comparison of Steady-State and Transient Performance of Servomechanisms. *R. W. Mayer, H. Chestnut*, General Electric Company

CP. Characteristics of Some Magnetic-Fluid Clutch Servomechanism Systems.** *A. J. Parziale, P. D. Tilton*

2:00 p.m. Substations

49-141–ACO.* Aluminum Alloy Substation Structures. *A. M. Baker*, Pennsylvania Electric Company

49-142–ACO.* Application of the "Multiplex" Scheme at Urban Distribution Substations in Baltimore. *M. Mortara*, Consolidated Gas Electric Light and Power Company of Baltimore

49-143. Automatic Grounding and Air Break Switches for Protection of Transformer Stations. *E. A. Ricker*, The Hydro-Electric Power Commission of Ontario

49-144. A New 2-Signal Supervisory Control System. *W. A. Derr*, Westinghouse Electric Corporation

2:00 p.m. Conference on Nucleonics

CP. Problems in Health Physics Instrumentation.** *Samuel Levin*, Massachusetts Institute of Technology

CP. Some Electronic Aids to the Nuclear Physicist.** *Emil de Agazio*, Massachusetts Institute of Technology

CP. Thickness Gauges in Industry Employing Radioactivity.** *J. R. Carlin*, Tracerlab, Inc.

CP. Scintillation Counters.** *William G. Cross*, Harvard University

Tuesday, June 21

9:30 a.m. Institute Publicity (Meeting of Section Delegates)

1. Purpose of Meeting. J. C. Strasbourger
2. Institute Public Relations. R. K. Honaman
3. Specific Section Publicity Problems
4. Mechanics of News Releases
5. News Stories for Electrical Engineering. C. S. Rich
6. Discussion of Publicity Material. G. T. Minasian
7. Summary

9:30 a.m. Symposium on Fundamental and Functional Design of Relay Switching Circuits

49-145. The Logic of Relay Circuits. *W. Keister*, Bell Telephone Laboratories, Inc.

49-146. Sequential Aspects of Relay Circuits. *A. E. Ritchie*, Bell Telephone Laboratories, Inc.

49-147. Relay "Trees" and Symmetric Circuits. *S. H. Washburn*, Bell Telephone Laboratories, Inc.

49-148. Counting With Relays. *G. R. Frost*, Bell Telephone Laboratories, Inc.

49-149. Codes and Translations. *Oscar Myers*, Bell Telephone Laboratories, Inc.

9:30 a.m. Carrier Current

49-150. Loss Measurements Made on Underground-Cable Overhead-Conductor 132-Kv Transmission Line at Carrier Current Frequencies. *H. A. Cornelius, B. Wade Storer*, Commonwealth Edison Company

49-151. Power Line Carrier for Relaying and Joint Usage—I. *G. W. Hampe, B. Wade Storer*, Commonwealth Edison Company

CP. Microwave Equipment for 900 and 2,000 Megacycles.** *W. E. Sutter, R. V. Rector*, General Electric Company

CP. Design and Plans for the Bonneville Microwave System.** *T. W. Stringfield*, Bonneville Power Administration

CP. A Place for Microwave Radio in the Power Industry.** *D. R. Pattison*, Pennsylvania Electric Company

CP. A Development of Microwave Equipment for Power System Applications.** *M. H. Wood, F. B. Gunter*, Westinghouse Electric Corporation

9:30 a.m. Radio Telemeter Instrumentation

CP. Upper Air Meteorological Telemetering.** *B. K. Hawes*, National Bureau of Standards

49-152. Automatic Range-Adjusting Radiosonde Recorder. *George E. Beggs, Jr.*, Leeds and Northrup Company

CP. A Pulse Width Modulation Telemetering System.** *Walter Hausz*, General Electric Company

CP. An FM-AM Telemetering System.** *W. J. Mayo-Wells*, Johns Hopkins Applied Physics Laboratory

2:00 p.m. Relays

49-153. Relaying of Transmission Lines From the New Sunbury Generating Station. *H. H. Green, J. A. G. Oewel, O. Ramsaur*, Pennsylvania Power and Light Company

49-154. Graphical Method for Estimating the Performance of Distance Relays During Faults and Power Swings. *A. R. van C. Warrington*, General Electric Company

CP. A New Loss of Excitation Relay for Synchronous Generators.** *C. R. Mason*

CP. Practice and Extent of Loss of Excitation on Rotating Machines.** *G. B. Miller*

2:00 p.m. Wide-Band Communication Media

49-155. B1 Alarm and Control System for Remote Control of Coaxial Cable Stations. *R. B. Hearn, Laurance A. Weber*, Bell Telephone Laboratories, Inc.

49-156. Power Supplies for Coaxial Systems. *H. H. Spencer*, Bell Telephone Laboratories, Inc.

49-157. Power Supplies for Microwave Relay Systems. *H. M. Ward*, The Western Union Telegraph Company

49-158. A Microwave Communication Relay System. *W. P. Boothroyd, H. J. Churchill*, Philco Research Division

2:00 p.m. Sections Committee Conference

2:00 p.m. Instruments and Measurements

49-159. A Thermal Converter for Telemetering and Totalizing. *W. C. Downing, Jr.*, Sangamo Electric Company

49-160. Heat Flow Ratio as a Design Parameter in Thermal Demand Meters. *J. S. Nelson*, General Electric Company

49-161. A New Expanded Scale A-C Voltmeter. *N. P. Millar*, General Electric Company

49-162–ACO.* A New Instrument Mechanism. *Allen Stimson, F. B. Jennings, C. W. McCarty*, General Electric Company

CP. Theoretical Considerations in the Use of an Ergmeter.** *J. Schroeder*, Naval Ordnance Laboratory

Wednesday, June 22

10:00 a.m. Annual Meeting

1. Report of Board of Directors. H. H. Henline, Secretary
2. Report of Treasurer. W. I. Slichter
3. Report of Committee of Tellers on vote for nominees for AIEE offices

4. (*a*). Introduction of, and presentation of President's badge to, J. F. Fairman.

(*b*). Response by Mr. Fairman.

5. Presentation of Lamme Medal to V. K. Zworykin, Vice-President and Technical Consultant, RCA Laboratories

(*a*). The Establishment of the Medal. Dr. N. S. Hibshman, Chairman, Lamme Medal Committee

(*b*). The Career of the Medalist.

(*c*). Presentation of Medal and Certificate by President Lee

(*d*). Response by Mr. Zworykin

6. Any other business that may be presented

7. Address, "The Expanding Horizons in Engineering Education," W. F. Ryan, Engineering Manager, Stone and Webster Engineering Corporation

8. President's Address. Everett S. Lee

2:00 p.m. Transformers

CP. Progress Report on Proposed Transformer Standards.** *AIEE Transformer Committee*

49-188. Economic Loading of a Transformer System. *D. L. Levine, H. E. Smith*, Commonwealth Edison Company

49-189. Heating of Transformers Under Short-Circuit Conditions. *V. M. Montsinger, G. H. Halsey*, General Electric Company

49-190. Standardization of Reactor Ratings. *F. H. Kierstead, J. L. Thomason*, General Electric Company

49-191. Transformer Audio Noise Problems on an Electric Power System. *C. S. Murray*, Consolidated Edison Company of New York Inc.

2:00 p.m. Computing Devices

49-163. A New Fourier Coefficient Harmonic Analyzer. *S. Charp*, The Franklin Institute

49-164. An Improved A-C Network Analyzer. *W. A. Morgan*, Bureau of Reclamation; *F. S. Rothe, J. J. Winsness*, General Electric Company

CP. The Bell Computer, Model VI.** *E. G. Andrews*

49-165. Application of the Cal-Tech Electric Analog Computer to Nonlinear Mechanics and Servomechanisms. *G. D. McCann, C. H. Wilts, B. N. Locanthi*, California Institute of Technology. Presentation by title only

49-166. Summary of Transformations Useful in Constructing Electrical Analogs of Linear Vibration Problems. *J. P. Corbett*, Northwestern University. Presentation by title only

2:00 p.m. Basic Science

49-167. Formulas and Tables for the Calculation of the Magnetic Field Components of Circular Filaments and Solenoids. *F. W. Grover*, Union College

49-168. General Theory, and Experimental Confirmation, of the Moving Coil Fluxmeter. *T. J. Higgins, Glenn Robertson*, University of Wisconsin

49-169–ACO.* Nomenclature for the Symbolic Treatment of Sinusoids. *W. R. LePage*, Syracuse University

49-170. Nonharmonic Oscillations as Caused by Magnetic Saturation. *Reinhold Rudenberg*, Harvard University

Thursday, June 23

9:30 a.m. Transmission and Distribution and System Engineering

49-171–ACO.* Planned Development of a Power System. *N. N. Smeloff*, Pennsylvania Power and Light Company

49-172. A 66-Kv Subtransmission Plan for a Metropolitan Area. *K. M. Smith, E. L. Michelson*, Commonwealth Edison Company

49-173. Comparative Performance Records of Steel and Wood Transmission Lines. *C. A. Booker*, New England Power Service Company

49-174. Stationary Networks and Transmission Lines Along Uniformly Rotating Reference Frames. *Gabriel Kron*, General Electric Company

49-175. Overcurrent Investigation on a Rural Distribution System. *G. F. Lincks*, General Electric Company; *D. R. Edge*, Graybar Electric Company Inc.; *W. C. McKinley*, Central Electric Cooperative, Inc.; *J. H. Leh*, General Electric Company. Presentation by title only.

49-61. Advances in Technique of Lightning Measurements. *T. Brownlee*, General Electric Company. Presentation by title only

49-177. Short-Circuit Currents and Recovery Voltages on Rural Distribution Systems. *W. H. Eason, I. B. Johnson, J. W. Kalb*, General Electric Company; *H. A. Peterson*, University of Wisconsin. Presentation by title only

9:30 a.m. Symposium on Electrical Properties of Semiconductors and the Transistor

(*A*). Nature of the Conductivity in Semiconductors, particularly Silicon and Germanium

CP. The Conductivity of Silicon and Germanium as Affected by Chemically Introduced Impurities.** *G. L. Pearson*, Bell Telephone Laboratories, Inc.

CP. Nucleon-Bombarded Semiconductors.** *K. Lark-Horovitz*, Purdue University

CP. The Control of the Conductivity of Oxide Semiconductors by Admixture of Other Oxides:** *N. C. Jamison*, Phillips Laboratories

(*B*). Photo Effects in Semiconductors

CP. General Features of Photoconductivity and Photoemission in Semiconductors.** *Lloyd Smith*, Cornell University

CP. External Photoelectric Effects in Semiconductors.**

CP. Internal Photoeffects in Germanium.** *J. N. Shive*, Bell Telephone Laboratories, Inc.

2:00 p.m. Transformers

49-192. Use of Thyrite in Power Transformers. *J. R. Meador*, General Electric Company

49-193. Controlled Temperature and Insulation Protection in the Operation of Power Transformers. *W. W. Satterlee, R. D. Reed*, Westinghouse Electric Corporation

49-194. A Small High-Voltage Bushing Design for High Altitude. *F. J. Vogel*, Illinois Institute of Technology; *H. A. Hart*, Armour Research Foundation

49-195. Extremes in the Insulation Co-ordination of Oil-Insulated Transformers. *F. J. Vogel*, Illinois Institute of Technology

2:00 p.m. Symposium on Electrical Properties of Semiconductors and the Transistor

(*C*). Semiconductor Rectifiers

CP. Theory of Rectification.** *F. Seitz*, Carnegie Institute of Technology

CP. A Comparison Between the Schottky Rectifier Theory and Measurements Upon Cuprous Oxide Cells.** *S. J. Angello*, Westinghouse Research Laboratories

CP. Boundary Layers in Rectifiers.** *H. Y. Fan*, Purdue University

CP. Noise in Semiconducting Contacts.** *P. H. Miller*, University of Pennsylvania

(*D*). The Transistor

CP. Theory of Transistor Action.** *W. Shockley*, Bell Telephone Laboratories, Inc.

CP. Equivalent Circuits for Transistor Action and Noise.** *R. M. Ryder*, Bell Telephone Laboratories, Inc.

CP. The Possible Significance of Transistors in the Power Field.** *J. A. Hutcheson*, Westinghouse Research Laboratories

2:00 p.m. Land Transportation and Lighting

49-176. Industrial Plants Prefer Diesel-Electric Switching Locomotives. *Thomas J. Woods*, Westinghouse Electric Corporation

49-186. Measurements of Erythemal Energy. *Hoyt S. Scott*, General Electric Company

49-187. Saving Time in Testing the Life of Incandescent Lamps. *W. R. Purcell*, Sylvania Electric Products

(Presentation of the foregoing papers will be followed by a meeting of the Land Transportation Committee)

Friday, June 24

9:30 a.m. Symposium on Primary Network Systems

49-178. Improvements to Oklahoma City Primary Network. *Bryce Brady*, Oklahoma Gas and Electric Company

49-179. Primary Networks on the Duquesne Light Company System. *W. P. Holben, J. E. Lange*, Duquesne Light Company

49-180. Design and Experience With 4-Kv Primary Network Systems in the Washington Area. *W. J. Lank*, Potomac Electric Power Company

49-181–ACO.* Primary Network Installations on the Boston Edison Company's System. *L. J. Weed*, Boston Edison Company

9:30 a.m. District Branch Prize Papers

Presentation of District Branch Prize Papers by the winners from the odd-numbered Districts (1, 3, 5, 7, 9)

9:30 a.m. Infrared Radiation

CP. The Basic Optics of Infrared Radiation.** *R. C. Lord*, Massachusetts Institute of Technology Spectroscopy Laboratory

CP. Radiation Detectors Applicable to Infrared Investigations.** *A. R. Dennett*, Eppley Laboratories

CP. A New Thermionic Detector for Infrared Radiation.** *E. D. Wilson*, Westinghouse Electric Corporation

CP. New Military Needs in the Infrared.** *C. S. Woodside*, Navy Bureau of Ships

CP. Industrial Applications of Infrared Spectroscopy.** *Van Zandt Williams*, Perkin-Elmer Corporation

9:30 a.m. Pulp and Paper

CP. Subcommittee Report on Electric Equipment for Paper Mill Supercalenders, Part I.** *V. B. Baker*, Westinghouse Electric Corporation

CP. Subcommittee Report on Electric Equipment for Paper Mill Winders.** *C. D. Beck*, General Electric Company

2:00 p.m. Electric Heating

49-182. Reduction of Interference From Radio-

—PAMPHLET reproductions of author's manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

—PRICES for papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPON books in nine-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the technical program committee ultimately will be published in Proceedings and Transactions; also, each is scheduled to be published in Electrical Engineering in digest or other form.

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*ACO: Advance copies only available; not intended for publication in *Transactions*.

**CP: Conference paper; no advance copies are available; not intended for publication in *Transactions*.

Frequency Heating Equipment. *G. W. Klingaman*, Radio Corporation of America

CP. High-Temperature Ceramic Insulations.** *Hans Thurnauer*

CP. Electrode-Type Electric Steam Boilers and Water Heaters.** *S. A. Williams*

CP. Temperature Measurement for Infrared Heating Processes.** *W. F. Hicks*

CP. Some Problems in the Measurement of Low-Intensity Fields at Ultrahigh Frequencies.** *C. W. Frick*

2:00 p.m. Magnetic Amplifiers And D-C Saturated Reactors

49-183–ACO.* Fundamentals of the Amplistat, a Magnetic Amplifier. *R. E. Morgan*, General Electric Company

49-140. Self-saturation in Magnetic Amplifiers. *W. J. Dornhoefer*, Vickers, Inc.

49-139. Analytical Determination of Characteristics of Magnetic Amplifiers With Feedback. *D. W. VerPlanck, L. A. Finzi, D. C. Beaumariage*, Carnegie Institute of Technology

49-198. A Method for Designing Pulse Transformers. *H. S. Kirschbaum, C. E. Warren*, Ohio State University

2:00 p.m. Storage Batteries

CP. Railway Battery Maintenance.** *E. K. Bloos*, Boston and Maine Railroad Company

CP. Prolonging Battery Life.** Doctor Eugene Willihnganz, Gould Storage Battery Company

CP. Design and Application of Dry Disk Rectifiers** *H. H. Zielinsky, E. A. Harty*, General Electric Company

2:00 p.m. Applied Mathematics

Introduction. M. G. Malti, Cornell University

CP. History and Co-ordination of Operational and Transform Methods.** *M. F. Gardner*, Massachusetts Institute of Technology

CP. Application of Operational and Transform Methods.** *L. A. Pipes*, University of California

49-184. A Derivation of Heaviside's Operational Calculus Based on the Generalized Functions of Schwartz. *J. J. Smith, P. L. Alger*, General Electric Company

49-185–ACO.* Correlation of the Methods of Operational Calculus. *W. A. Lewis*, Illinois Institute of Technology

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*ACO: Advance copies only available; not intended for publication in *Transactions*.

**CP: Conference paper; no advance copies are available; not intended for publication in *Transactions*.

activities for students. In the morning the winners of the District prizes from the odd-numbered Districts (this being an odd-numbered year) will present their papers before a joint student and member session. The afternoon will start with a special luncheon, as guests of the General Electric Company at the Thompson Club, Nahant, Mass. Transportation will be provided. The day will wind up with either a boat trip or field day where tennis, baseball, or swimming can be enjoyed on the grounds of the Thompson Club. The wives of students are cordially invited to attend.

Students *outside of District 1*, who plan to attend on Friday, June 24, should write to Professor E. W. Boehne, Massachusetts Institute of Technology, Cambridge, Mass. If quarters other than the New Ocean House are desired, this information should be included.

The Student Committee includes: A. H. Howell, Tufts College; F. B. Naka, Harvard University; C. E. Richards, Northeastern University; E. W. Boehne (*Chairman*), Massachusetts Institute of Technology.

SECTION DELEGATES TO DISCUSS PUBLICITY

A special session to discuss Institute and Section publicity has been scheduled for Section delegates at the meeting. The session will be held in the ballroom of the New Ocean House at 9:30 on the morning of Tuesday, June 21.

The program of publicity discussion has been arranged by the Committee on Public Relations under the chairmanship of R. Karl Honaman, in collaboration with J. C. Strasbourger, Chairman of the Sections Committee. There will be several brief talks by publicity specialists, and a detailed discussion of a kit of instructions and sample news releases designed to assist the Sections in handling local and regional press relations and news stories for trade magazines. C. S. Purnell, Vice-Chairman of the Sections Committee, will preside.

This meeting of the Section delegates is a step towards formulating a continuous and integrated program of information for the public concerning the affairs of the Institute.

SUMMER GENERAL MEETING COMMITTEE

The personnel serving on the Summer General Meeting Committee includes the following:

E. W. Davis, *General Chairman;* M. A. Princi, *Vice-Chairman;* R. E. Muehlig, *Secretary-Treasurer;* R. G. Porter, R. G. Slauer, F. P. Taugher, *Members-at-Large*

Also included are the chairmen of the various other meeting committees:

A. L. O'Banion, *Registration;* H. B. McIntyre, *Publicity;* G. J. Crowdes, *Entertainment and Banquet;* A. B. Whitehouse, *Transportation;* R. G. Connors, *Hotels;* J. R. Macintyre, *Inspection;* C. A. Corney, *Finance;* E. W. Boehne, *Students;* J. O'R. Coleman, *Meetings and Papers;* F. S. Bacon, Jr., *Hospitality;* Mrs. F. B. Haeussler, *Ladies;* A. F. Lukens, *Sports*

Industrial Applications Featured at Buffalo Electron Tube Conference

Industrial applications of electron tubes was the subject of the second AIEE conference on electron tubes which attracted an audience of more than 238 persons in Buffalo, N. Y., April 11–12, 1949. Sixth in the series of the new type of AIEE meetings—known as the AIEE Conference—(*EE, Feb '48, p 189*), this was the second one on the subject of electron tubes, the first being held in Philadelphia, Pa., March 29–30, 1948. This year's conference was sponsored jointly by the AIEE Subcommittee on Electron Tubes of the AIEE Electronics Committee, the AIEE Subcommittee on Electronic Control of the AIEE Industrial Control Committee, and the Niagara Frontier Section of AIEE.

PURPOSE OF CONFERENCE

The purpose of the conference was to provide an opportunity to discuss the applications of electron tubes in the industrial field, and the 2-day program which included some 20 papers, was planned to cover ex-

At the speakers' table during the dinner which was a feature of the recent Conference on Industrial Applications of Electron Tubes in Buffalo, N. Y., are shown, left to right: E. H. Vedder; W. C. White; R. S. Gardner; H. L. Palmer; Dr. K. H. Kingdon, main speaker of the evening; Professor W. G. Dow, toastmaster; H. C. Steiner; O. W. Livingston; J. E. Sowers; H. F. Dart

periences of the users and designers of equipment utilizing electron tubes, as well as those responsible for designing and rating industrial electron tubes. The four sessions included such subjects as industrial electronic applications, problems of electronic equipment users, problems of electronic equipment design, and those of the tube designer.

J. E. Sowers, Chairman of the AIEE Niagara Frontier Section, welcomed the visitors to the conference. A few remarks outlining the general program were presented by H. L. Palmer, who also acted as conference cochairman. A review of last year's Conference on Electron Tubes for Instrumentation and Industrial Use was presented by J. G. Reed, Jr., Chairman of the Joint Subcommittee on Electronic Instruments.

SESSION SUBJECTS

The subject of the first session was industrial electronic control applications, and was presided over by W. C. White of General Electric Company, Schenectady, N. Y. Speakers outlined the progress already made in the field of electronic control in industry. Included were technical considerations in the application of electron tubes to such fields as control of d-c motors, regulators and regulating systems, control of a-c power, relaying devices, and photoelectric control.

Problems of electronic equipment users were the subject of the second session, which was presided over by J. A. Gienger, Eastman Kodak Company, Rochester, N. Y. Two papers were presented during this session, one on maintenance of electron tubes and controls in industry by M. A. Dragics, Owens Corning Fiberglas Corporation, and the other on functional life tests of high-vacuum tubes by J. L. Wagner and K. Koos, International Business Machines, Endicott, N. Y. The most important problems that the users face, according to these papers, was that of training maintenance personnel, a need for more basic research to determine why tubes fail, and an accurate means of determining tube life to minimize unscheduled interruption of production caused by tube failures in control equipment.

The third session was devoted to problems of electronic equipment design and was presided over by H. L. Palmer, General Electric Company, Schenectady, N. Y. Tube ratings as applied to industrial control equipment, desirable improvements in tube characteristics and ratings, mechanical defects in tubes, problems related to components used in industrial electronic equipment design, and selection of use of capacitors in electronic control equipment, were among the topics discussed.

Professor C. H. Willis, Princeton University, Princeton, N. J., presided over the fourth and last session which was devoted to problems of the tube designer. The topics discussed in this session were devoted mainly to an explanation of how various types of industrial tubes are rated, and the reasons for these ratings. The topics included ratings of ignitrons for a-c control, ignitrons for rectification, mercury thyratrons, inert gas tubes, radio receiving-type tubes, and phototube characteristics.

The conference program included an inspection trip of Westinghouse Electric Corporation's Buffalo plant where a large variety of industrial electronic control equipment was being manufactured. On Monday evening a dinner was held and Professor W. G. Dow, University of Michigan, acted as toastmaster. The main speaker of the evening was Dr. K. H. Kingdon, assistant director of the General Electric Research Laboratory in charge of the Knolls Atomic Power Laboratory, who spoke on "The Production and Utilization of Nuclear Fuel." He described how an atomic reactor operates and the General Electric Knoll's Atomic Power Laboratory now undergoing construction.

H. C. Steiner, conference cochairman, ended the conference by summarizing the results of the 2-day discussions. He pointed out the need for longer tube life, better quality of tubes, more standardization in the industrial tube manufacturing industry, and a better understanding of the basic physics underlying tube emission.

In addition to digests of most of the papers presented at the conference, which appear in this issue (*pages 525–30*), the full text of the papers and discussions presented are in preparation and soon will be available, at $3.50 each. Advance orders for the publication should be sent, with remittance, to R. S. Gardner, AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Copies of the booklet embodying the papers presented at last year's conference are still available and may be obtained from the AIEE Order Department, 33 West 39th St., New York 18, N. Y., as follows:

"Report on Electron Tube Survey of Instrument Manufacturers and Laboratories" at $2 per copy ($1 to AIEE members)

"Conference on Electron Tubes for Instrumentation and Industrial Use" at $3 per copy ($1.50 to AIEE members)

A special combination offer wherein both publications ordered at the same time may be had at the special price of $2 to AIEE members and $4 to nonmembers.

COMMITTEES

Several committees were responsible for the success of the Buffalo conference. These include the following:

Program Committee: O. W. Livingston, *Chairman,* W. H. Elliott, *session 1;* J. W. Picking, *session 2;* J. D. Sauter, *session 3;* D. E. Marshall, *session 4;* R. W. Staggs, *inspection trip;* D. V. Edwards; K. P. Puchlowski; H. L. Palmer; H. C. Steiner

Publicity Committee: H. F. Dart, *Chairman;* R. E. Graham; C. S. Brumbaugh

Publication Committee: K. P. Puchlowski, *Chairman;* B. F. Tellkamp

Niagara Frontier Section Committee: E. H. Vedder, *General Chairman;* C. J. Brumbaugh, *Vice-Chairman;* T. O. Zittel, *Treasurer;* R. G. Harper, *publicity;* V. A. Leitzke, *registration;* D. J. Munhall, *hospitality;* K. P. Puchlowski, *publication*

In addition, the Executive Committee consisted of Conference Cochairmen H. L. Palmer and H. C. Steiner and Treasurer T. O. Zittel. Headquarters representatives at the conference were R. S. Gardner, and Associate Editor E. E. Grazda of *Electrical Engineering.*

Analysis of Registration, Conference on the Industrial Application of Electron Tubes, Buffalo, N. Y.

District	Members	Nonmembers	Totals
*1	57	63	120
2	18	22	40
3	12	17	29
4	0	1	1
5	20	10	30
6	0	0	0
7	0	2	2
8	0	0	0
9	0	0	0
10	5	11	16
Totals	112	126	238

* District in which meeting was held.

Engineer's Role in Growth of Southwest Is Theme of Successful Meeting in Dallas

The 3-day meeting of the AIEE South West District, held in Dallas, Tex., April 19–21, 1949, featured "The Electrical Engineers' Contribution to the Growth of the Southwest." This theme was the subject of one of the general sessions and an address at a preceding luncheon meeting entitled "Economic Development of the Southwest" by John F. Falvey, Consultant in Public Utility Relations, served admirably as an introduction. Many of the papers which were presented in the seven technical sessions completing the program testified as to the many ways in which electrical engineers are meeting this challenge in a region of extremely rapid growth. In addition, two sessions were held in which papers were presented by the students, and inspection trips were taken to nearby industries with entertainment in the evenings and a specially arranged program for the ladies. The total attendance of 783 members, guests, and students, evidenced one of the most successful District meetings in the annals of the Institute.

OPENING MEETING

The meeting was opened by Elgin B. Robertson, General Chairman, who introduced the other members of the District Meeting Committee. Thanks and appreciation were expressed for the arrangements made as well as to those who would preside and present papers. The next speaker, Vice-President George N. Pingree, explained the rapid growth in the petroleum and chemical industries as well as in the electrical industry which has surged ahead with great rapidity since V-J Day. He stated that the members of the new generation must more than be technicians; they must be professional engineers and the future depends upon the students of today. He remarked that since the AIEE was founded, it has been fortunate in leadership and he introduced President Lee as one who has carried the message of Institute work to every part of the country.

OUR INSTITUTE

In his opening remarks, President Lee called attention to the theme of the meeting.

Chairman O. S. Hockaday of the Meeting and Papers Committee at the recent South West District Meeting in Dallas

Elgin B. Robertson, General Chairman of the 1949 South West District Meeting

John W. Carpenter, President of the Texas Power and Light Company, who conducted the general session

"What Electrical Engineers are doing to Meet the Needs of the Growing Southwest." His message was inspiring as he brought with him valuable experiences out of having visited various Sections throughout the country from the time of the inauguration of the 82d Section in Richland, Wash., with a surprising turnout of 168 people up to the present. He referred to meetings in Arizona and Florida where members came from considerable distances away to attend and he stressed the value of friendships in the Institute. He pointed out that in back of all progress stands the civil, chemical, and mechanical engineers, and in back of the telephone, telegraph, radio, great power developments, transmission, distribution, and utilization of electric energy stands the electrical engineer. The Institute membership has grown to 31,000 with 84 Sections and 129 Branches and with close co-ordination between the Sections and Branches.

With the increase in growth of the Institute and rising costs, President Lee outlined steps which have been taken to operate within a balanced budget. He cited the fact that Past-President Hull was among the first to increase the income. The price for preprints was raised to 30 and 60 cents per copy to make them more nearly self-supporting. In connection with meetings, there had been a debit of some $31,000 per year which has been offset largely by the introduction of a registration fee of $2 to members and $3 to nonmembers for the District meetings, with a fee of $3 for members and $5 for nonmembers at the general meetings. The yearly page content of *Electrical Engineering* had been slightly reduced by 135 pages effecting a saving of some $16,000 with the advantage of less weight and these pages have not been missed by the members. In these ways expenses have been kept within income. As to the future, President Lee explained that the Board of Directors had requested all committees to make 5-year estimates which were due on April 1 and the final report would be made at the time of the Summer General Meeting.

With reference to the studies which have been made in regard to the organization of the engineering profession, the speaker explained that Plan *D* for an over-all engineering organization had been referred to the Engineers' Joint Council. Many of the younger engineers were in favor of this plan because they felt it would bring about greater recognition. Speaking from experience, President Lee explained that professional recognition comes largely from contacts with the public rather than from the engineers' contact with engineering societies. Medical doctors come in close contact with the personal lives of their patients. President Lee explained that engineering registration is at least 25 years old and that there is now a law in every state a test to the ability of engineers to take hold in matters. The National Society of Professional Engineers has been growing rapidly and all matters pertaining to licensing should be processed through the state societies. In conclusion, President Lee urged all engineers to be the best engineers possible but to allow some time for other activities.

ELECTRICAL ACTIVITY IN CRYSTAL STRUCTURE

The meeting was addressed by Dr. Jack T. Wilson, Physicist, Allis-Chalmers Manufacturing Company, on the subject of "The Significance of Electrical Activity in Crystal Structure." Dr. Wilson spoke of work with aluminum phosphate crystals and of the work done by Dr. Fallon of the University of Toronto in implanting active crystals in the lung tissue of animals. He explained the danger of beryllium oxide and the growth of tissue at the point of cut.

With regard to silicosis, he referred to the mining of diatomaceous earth in central Italy. Workers handling the material before it was heat-treated were found to be free of silicosis. The lung tissue of workers who handled the material after it had been heat-treated in a kiln at a high temperature were found to suffer from silicosis on examination. He explained that the heat treating process had changed the crystalline structure to electrically active material and that this discovery constituted the basic contribution of the electrical engineer to medical science.

LUNCHEON MEETING

The principal feature of a well-attended luncheon was an address "Economic Development of the Southwest," by John F. Falvey, Consultant in Public Utility Relations—Financial and Public. State by state and city by city, Mr. Falvey presented data and analyzed them to show the phenomenal growth of the Southwest in recent years. From a recent study made by The Territorial Information Department of Chicago, he pointed out that 279 new industrial plants valued individually at $100,000 or more had located in the Southwest in the $3^1/_2$ postwar years from July 1945 through December 1948 or had contracted for construction in that period. This was 10 per cent of the 2,663 new plants built or contracted for throughout the entire country in the same period. He pointed out that still more significant was the fact that these Southwestern plants had a value of $353,000,000 or 16 per cent of the $2,147,900,000 value of plants building or proposed for the entire country in the same 42 months. Texas was the leader in this sharp expansion with 263 new plants contracted for at a price of $323,400,000 with the 94 per cent of the Southwestern plants and 92 per cent of their contracted investment value. This industrial development was not considered a postwar flash, but the location of war plants in the area to avoid bomb threats and to get nearer the source of raw material supplies did give the Southwest some 600 war plants at a cost of about $1,500,000,000. Many of these war plants have been successfully converted to peacetime utilization. As to the refineries, chemical plants, and basic metal facilities, these have continued in operation and the smaller ordnance plants have shifted to fabrication of steel and to the production of metal products. Numerous other smaller plants have converted to food processing and to production of rubber goods, glass, and other items. Utilization of these war-built facilities, in addition to stimulating employment, has diversified the industrial structure of the Southwest. Chemical plants have accounted for 80 per cent of new plant construction in Texas in the three years ended last July. Chemical plants are important because of the synthetic products, rubber, carbon black, plastics, paint, and so on, and the various other segments of industry which they attract into an area. Similar reports from neighboring states all showed industrial gains, some brought about through the activities of state planning agencies which have been instrumental in attracting industries and processing the natural resources of the localities. Kansas and Arkansas have gained back some of the population lost a decade ago.

As for the present and the immediate future, Mr. Falvey drew on reports from the Federal Reserve Banks of the districts, the railroads, and The College of Business Administration of the University of Oklahoma which indicated that the construction of manufacturing plants has fallen off below the levels of a year ago. However, the causes which usually generate a violent business reversal are not present as yet. After the present period of levelling off or a period of readjustment, an upsurge was predicted and the speaker cited the report of Dr. Virgil D. Reed, aptly titled "Jack Pot for 1960" which was carried in "Nations' Business," February 1949 edition of the *Readers Digest*. By that time, national population will have increased nearly seven per cent and from about 1962–1970, Dr. Reed predicted that we will hit a real jack pot with another six million people added to our population. The estimate was predicated on the sharp wartime and postwar increase in the marriage rate.

In considering the economic growth of the region, the speaker mentioned some of the adverse factors such as the need to develop underground and ground water supplies to meet increasing demands. While there is plenty of surface water in most parts of the Southwest, it would take time and a lot of money to construct dams and impound the streams—even then, the relative warmth of the surface water and its tendency to pick up impurities would limit its usefulness. This factor, together with the need to construct recreational, church, school, hospital, and highway facilities, would mean ever-increasing tax burdens. These various social factors are considered of the utmost importance if industrial growth is to be sustained and maintained.

In conclusion, Mr. Falvey complimented the utilities in the region on having done a magnificent job in the past few years in taking care of sharply expanding loads and in helping to promote the self-sufficiency of the growing area. He warned that the "breather" or rest period might not come and if it does, it probably will be of short duration. All authorities on whose collective thinking the speaker had drawn seemed agreed that the recent dropping off of the rate of industrial expansion is merely a temporary development. From budget estimates which he had seen, Mr. Falvey stated that the utilities were aware of the immensity of the task with which they are confronted. Utilities in Missouri anticipate from 32 per cent to 37 per cent further gain in peak demand in the five years through 1953. Industrial growth in Kansas, for the same 5-year period, will mean roughly another 25 per cent or so gained in peak demand on the systems. In Texas the outlook seems to range from a 20 per cent gain in 1949 over 1948 to about a 40 per cent gain between last year and 1953, and in the city of Houston, the peak demand by 1951 is esimated to be around 50 per cent to 60 per cent above 1948's high level. Similar expansion is anticipated for the eastern portion of Texas, bordering on Arkansas and Louisiana. When an area realizes its problems and when business, farm, and financial groups act in concert to overcome them, a long forward step has been taken and one can feel reasonably sure of a favorable outcome.

The Luncheon Meeting was presided over by J. B. Thomas, who took occasion to introduce President Lee; the presidential nominee, J. F. Fairman; Past-President Blake D. Hull; and Secretary H. H. Henline; as well as the speaker.

THE ELECTRICAL ENGINEERS CONTRIBUTION TO THE GROWTH OF THE SOUTHWEST

A well-rounded symposium on the subject of "The Electrical Engineers Contribution to the Growthof the Southwest," was presented from five different points of view, the electrical utilities, communication companies, heavy industry, manufacturers, and educational institutions, by speakers who are well qualified in these respective fields. The meeting was ably conducted by John W. Carpenter, President of the Texas Power and Light Company, who appropriately interjected remarks from a background of more than 50 years experience in the utility field. In opening the meeting, he stated that no association in the history of this country has rendered more to the people than the members of the AIEE. The South West District was considered by Mr. Carpenter one of the greatest of the ten Districts, with the most opportunity, and he considered Texas as the hub of the Western Hemisphere and as the safest area from bomb threats. He stressed the importance of aviation in carrying on a war and he cited the importance of electrical engineering in the development of aviation and transportation. The region has tremendous responsibilities for the future.

Electrical Utilities. From the point of view of the electrical utilities, George L. MacGregor, President of the Dallas Power and Light Company, presented charts and figures to show how the utility plants have kept pace with the extremely rapid growth of the region. With the end of the war, demands did not cease, but the load jumped up. Power curtailment was very limited and only for the duration of certain periods. With present capacity at 2,292,000 kw, new plant capacity will be added right along and some utilities will have more than doubled their plant accounts in the next five years. Mr. MacGregor pointed out that costs are down 27 per cent while the cost of living is up. There has been a saving in plant operation through fewer attendants, interconnected systems, the ability to operate lines at higher voltages, and lower cost of capacity in larger units. They now are thinking in terms of 60,000-kw units, illustrated by the Mountain Creek Station. All of these factors, which are contributions of the engineers, have made it possible in the utilities to operate through the last five years without raising rates. In conclusion, he explained that government hydroelectric power, if sold in competition, would be disastrous, but if intergrated with the present steam generating system, it would be a great benefit.

Communication Companies. From the point of view of communications, H. R. Fritz, Chief Engineer of the Southwestern Bell Telephone Company, presented charts and data to show the enormous increases in plant investment, station growth, miles of circuits, and rural statistics which have taken place in the six states of the Southwest and in Texas alone in recent years. He pointed out that 109,000 stations and substations have been added since 1940, and the number of circuits involved have more than doubled in the last two years.

With respect to the future, Mr. Fritz explained that 101 new buildings are underway in the Southwest, 77 of which will be in Texas. With respect to new types of service, he mentioned the mobile radio, telephones, underground coaxial cables, and a nationwide toll dialing system.

The importance of the telegraph in the rapidly expanding industrial Southwest was cited by Mr. Fritz and he presented data furnished by F. B. Bramhall of the Western Union Telegraph Company in regard to the "Record Communication Facilities." Four automatic telegraph switching centers which give instantaneous direct service to a total of 11 such area centers serving the rest of the nation have been installed recently. Through these centers, message traffic is flashed to its destination without manual retransmission at an unprecedented speed. The newer and finer telegraph service represents a $70,000,000 expenditure with Dallas as a communication hub. To provide a network of additional channels necessary for the operation of a new system, various systems are being used which permit the transmission of as many as 288 telegrams simultaneously over a pair of wires. The number of carrier circuits was doubled in 1948 and there is now in operation 1,410,000 channel miles of carrier systems.

In conclusion, Mr. Fritz mentioned the time saved by new machines and he described as outstanding the "Desk-Fax," a miniature facsimile machine which brings world-wide telegraph and cable communication within arms reach of the user. With this machine, the sending of a telegram is reduced to the simple process of placing a message on a cylinder and pressing a button. Electric impulses transmitted as a stylus passes over the message, flash over the wire and cause the receiving machine to create an exact pictorial reproduction of a special telegraph blank. The "Desk-Fax" is also a receiving machine and soon will be placed in offices of businessmen in Dallas and Houston, providing continuous telegraphic connection.

Heavy Industry. The point of view of heavy industry was expressed by G. R. Walton, Industrial Representative of the United Gas Pipe Line Company. He explained that the South and Southwest long had been shipping out raw materials, but that situation soon would be improved. He considered the saw mills to be one of the most stable industries which will be active long after the sulfur, oil, and gas have been depleted. Reforestration is going on rapidly and six million pine seedlings will be set out in 1949. In a favorable climate, southern pine seedlings grow to 8-inch calibre in about eight years. Improvements in material handling, treatment, and disposal of waste materials all provide increased opportunities for trained engineers.

With respect to iron and steel, he pointed out that Oklahoma has large deposits which compare favorably with the Birmingham area and there is also limestone and coal nearby. With the expansion of the Houston Steel Plant, the industry was here to stay and grow, and he again cited the importance of the electrical engineer in developing and applying precision control. In respect to the oil and chemical industries, Mr. Walton drew attention to electric compressors, fully automatic electric pump drives, and the possibilities of developing a vast variety of synthetic products in regard to which no one could gauge the future. In all these activities, he placed the electrical engineer with his knowledge of control systems and of instruments as a very important individual.

Manufacturers. From the point of view of the electrical manufacturer, W. J. Donald, President of the National Electrical Manufacturers Association, cited numerous contributions of the electrical engineer with respect to the special requirements of the industries in the region. In connection with the mining and petroleum industries, he cited the development of dampproof and explosion-proof equipment, as well as the development of seamless steel tubing and the welding equipment to produce the results. He referred to the fact that the gas turbine is a complete unit which will become more economical as labor costs increase. In reference to oil well drilling, he cited that electric power has increased the flexibility and control of this operation and there is a trend to use more electric power for deep well drilling beyond 10,000 foot depths. Also in connection with oil well pumping, splashproof equipment has been valuable. He pointed out that with electrolytic processes large quantities of cheap power are essential and data were given on the generating capacities required. He pointed out also that generators have been made so reliable that they can be located in less accessible places. The importance of the rectifier in these industries was mentioned. The speaker referred to the nonferrous metals industries, copper, gold, silver, lead, large deposits of which are located by electrical instrumentation. Specially designed equipment has been developed for use in the damp locations underground. In speaking of the central station industry, he referred to the unit substations and the great increase in kilowatt sales which were about four times in 1947 what they were in 1927. He also spoke of the improvements in domestic appliances, refrigerators, ranges, and so on, and the greatly increased number of these appliances which have been installed. In conclusion, Mr. Donald stated that the contribution of the electrical engineer has been greatly to increase the efficiency of all apparatus.

Educational Institutions. For the educational institutions, an excellent survey of the situation was presented by Dr. Umphrey Lee, President of Southern Methodist University. In regard to the number of electrical engineers necessary, Dr. Lee frankly stated that he did not know. The number of engineers in any factory is a small proportion of the total employees, but they are a small proportion which cannot be neglected. The speaker drew an interesting comparison between the number of engineers turned out in the six Southwestern states as compared with the four states bordering on the Chicago area. Last year 910 undergraduate engineers were turned out in the Chicago area, whereas in the six Southwestern states, the number was 610. The number of doctorate degrees, in the Chicago area, was 45 as compared to only one in the Southwestern states. Dr. Lee concluded that the Southwest was turning out as many undergraduate engineers as were needed, but he stated that the colleges need the help of industry and that it is not a good idea to graduate more engineers than can be absorbed. Thus he suggested that industry and education should get together.

In conclusion, Dr. Lee spoke on the quality of engineers and it was his belief that they ought to have a little bit more than engineering. He personally believes that the engineers in Europe, as well as the doctors and other technical men, have been simply the hired men. He suggested that engineers change their ideas about politics as they have a stake in such matters, and that since brains are needed there, engineers should take their proper political responsibilities.

TECHNICAL SESSIONS

In the seven technical sessions which were held, many of the papers and discussions supplemented the general theme of the meeting in that they brought out the lastest designs and practices in the region of the Southwest. For example, a paper was presented on "Performance of Diesel-Electric Rig for Deep Well Drilling," by E. C. Clark of the General Electric Company, in which the characteristics of flexibility of this type of rig with its Ward-Leonard control were clearly brought out by the author. The advantages of engine operation at reduced speeds and the flexibility of control were brought out by the coauthor, B. L. Moore of the Humble Oil and Refining Company. After $2^1/_2$ years' service, one diesel engine was taken down which required no new rings or pistons, resulting in considerably lower engine maintenance. In another paper, "The Need of Lightning Protection for Rotating Electric Prime Movers in Pipe Line Stations," the question of lightning protection in an area of severe lightning exposure was thoroughly discussed. In the same session, still another paper described a large paper mill and the attendant problems, and another described the large electrolytic zinc plant of the American Smelting and Refining Company at Corpus Christi, Tex.

In another session on power generation, "The Combustion Gas Turbine and Its Application as a Prime Mover for the Generation of Electric Power, and Other Uses," was described by B. G. Hatch of the General Electric Company. This newest type of prime mover is particularly adaptable in the region of the Southwest where there is a scarcity of water and an abundance of fuel. In addition to the foregoing advantages, Mr. Hatch mentioned a number of other advantages and possible applications. He stated that the gas turbine is a complete power plant in one unit with reasonably small dimensions, so the requirements for foundation and building are a minimum. In units with an increment from 3,500 to 5,000 kw, gas turbine application seems limited as a base load power plant on small systems and for use at the end of transmission lines at peak loads. It can be started in a matter of minutes and so it can be shut down. It also has possibilities as a 3,500-kw mobile unit car or a 5,000-kw mobile unit mounted on two cars. There is the possibility of adding a third car which would be the electric substation, circuit breakers, and other apparatus. Mr. Hatch also cited the possibility of application of the gas turbine as a mechanical drive unit for fuel and pipe line pumping. He stated that so far six units have been sold and by the end of the year there will have been four or five units in operation.

Other sessions dealt with the problems of relays and protective devices, transmission and distribution, as well as the newest of energy sources "nucleonics."

STUDENT SESSIONS

During the meeting, two student sessions were held in which papers were presented by the students as follows:

"Determination of Transmission Line Faults by Pulse Reflections," Fred B. Clark, University of Arkansas

"A Study of the Characteristics of Electronic Organs," Robert G. Lewis, Kansas State College

"Magnetic Amplifiers," Bill Hamilton, University of Kansas

"An Investigation of Uniformly-Loaded Antennas," Edwin L. Hughes, Missouri School of Mines

"Frequency Conversion by Modulation," R. H. Buescher, University of Missouri

"Wound-Rotor Induction Motor With Unbalanced Rotor Circuits," Dallas C. Allred, New Mexico College of Agricultural and Mechanical Arts

"A Visual Method of Frequency Response Measurement," Loyle E. Baltz, University of New Mexico

"Liquid Level Measurement and Control by Gamma Radiation," W. H. Wards, Jr., Oklahoma Agricultural and Mechanical College

"Regenerative and Degenerative Feedback in Saturable Reactors," Howard B. Hamilton, University of Oklahoma

"A Method of Measuring the Viscous Properties of Magnetic Fluids," J. H. Vogt and R. Hunt McKinley, Rice Institute

"Introduction to Geophysical Prospecting," John W. Roby, Southern Methodist University

"A Portable D-C Calculator," H. R. McKenzie, Agricultural and Mechanical College of Texas

"An Interesting Application of Coupled Circuits," B. J. Carr, Texas Technological College

"The Phasing System of Single Side Band Suppressed Carrier Transmission," Kerns H. Powers, University of Texas

F. W. Tatum presided at the Tuesday afternoon session and Paul C. Petty presided at the Wednesday morning session.

At the banquet in the evening, Vice-President Pingree announced the awards of the judges. The District Prize for Branch Paper was awarded to J. H. Vogt and R. Hunt McKinley from Rice Institute for their paper entitled, "A Method of Measuring the Viscous Properties of Magnetic Fluids." The paper by Robert G. Lewis of Kansas State College was judged second best and the paper by Kerns H. Powers of the University of Texas was awarded third place.

PRESIDENT LEE'S ADDRESS

President Lee addressed the students from a wealth of experiences after having talked to about 50 Branches. While in Spokane, Wash., he told of a conflict with an evening student session, which he resolved by going to the ball game. On the following morning, he was gratified at another student session when the chairman announced that the meeting would close promptly at 12 so that they could play golf. He advised the students that the world needs engineers for engineering, but he suggested that they broaden themselves and not give all of their time to engineering, but meet others in their work at school and engage in civic and community activities.

In reference to the luncheon address by Mr. Falvey, President Lee stated that the engineer must have a knowledge of economics. In engineering problems, there is an opportunity to control matters, but in life, control and the handling of others is a very difficult problem and engineers often will find themselves in unfavorable positions.

While at Lehigh University, it was drawn to the attention of President Lee that that was the first Branch in the Institute. It was founded by the late Charles F. Scott, Past-President, who visualized the organization of many Branches in the future, and President Lee stated that Professor Scott would have been happy to see the 129 Branches now in existence. In conclusion, President Lee said that he was happy to be with the students and he commented on the excellent papers on the program.

SOCIAL ACTIVITIES

On Tuesday evening, a number of members and students attended the smoker and buffet supper held in the Peacock Terrace. Entertainment was furnished by troubadours.

On Wednesday noon, a luncheon was held honoring the Board of Directors in the Roof Garden of the Adolphus Hotel. President Lee introduced the members of the Board, as well as several women engineers who were present. Vice-President Pingree introduced Professor F. W. Tatum, Chairman of the District Committee on Student Activities, who in turn introduced the representatives of the 14 of the 15 Branches who were present.

In the evening, the banquet and dance was held in the Crystal Ballroom of the Baker Hotel with Al Jones acting as toastmaster. Songs of the South were rendered by the Streamline Trio of the Texas and Pacific Railroad.

INSPECTION TRIPS

During the meeting, trips were taken to engineering features of interest which exemplified the growth of the Southwest. Among the places visited were the Haskell Toll Office of the Bell System, the New Handley Power Station of Texas Electric Service Company in Fort Worth, and the new *WBAP—TV* Television Transmitter and Studio. Still another trip was arranged to the *Dallas Morning News*.

WOMEN'S ENTERTAINMENT

After getting acquainted, the women had a busy time during the meeting. Hostesses were available to help arrange sight-seeing, shopping, and other activities. On Tuesday evening, there was a dinner in the Century Room of the Adolphus Hotel, followed by an unusual and attractive Ice Show. On the following day, there was a luncheon and style show presented by the world-famous Neiman-Marcus store, and in the evening, the banquet and dance. The next day, a conducted tour of some of Dallas' exclusive residential areas and beautiful flower gardens was arranged.

COMMITTEES

The officers of the District Meeting Committee were as follows:

Elgin B. Robertson, *Chairman;* P. G. Wallace, *Vice-Chairman;* C. Walker Mier, *Vice-Chairman;* George N. Pingree, *Vice-President of South West District;* Gibbs A. Dyer, *Secretary*

The chairmen of the subcommittees which made the arrangements were as follows:

O. S. Hockaday, *Meetings and Papers;* George A. Smith, Jr., *Hotel and Reservations;* C. M. Mackey, *Transportation and Inspection Trips;* A. L. Jones, Jr., *Entertainment;* Mrs. E. N. Jolliff, *Ladies' Entertainment;* Harry R. Pearson *Publicity;* R. L. Biesele, Jr., *Student Activities;* C. C. Musgrove, *Finance*

AIEE Board of Directors Holds Regular Meeting in Dallas, Tex.

A regular meeting of the AIEE Board of Directors was held in the Mercantile Bank Building, Dallas, Tex., Wednesday, April 20, 1949.

President Lee reported briefly upon visits which he had made to many Sections and Student Branches since the meeting of the Board of Directors on February 3. All of the vice-presidents present and Directors Flanigen and North mentioned briefly visits made by them.

The minutes of the meeting of the Board of Directors held in New York, February 3, 1949, were approved.

Actions of the Executive Committee on Membership Applications were reported and confirmed, as follows. As of February 25, 1949: 5 applicants transferred and one applicant elected to the grade of Fellow; 20 applicants transferred and 38 elected to the grade of Member; 146 applicants elected to grade of Associate; 441 Student Members enrolled. As of March 23, 1949: 2 applicants transferred to grade of Fellow; 21 applicants transferred and 25 elected to grade of Member; 159 applicants elected to grade of Associate; and 1,068 Student Members enrolled.

Recommendations on membership applications adopted at meetings of the Board of Examiners held February 17 and March 17, 1949, were reported and confirmed. The following actions were taken upon recommendation of the Board of Examiners: 7 applicants were transferred to the grade of Fellow, 55 applicants were transferred to the grade of Member, 1,544 applicants were elected to the grade of Associate as of May 1, 1949, and 689 Student Members were enrolled.

FINANCES

Monthly expenditures were reported by Chairman Yerkes of the Finance Committee and confirmed by the directors, as follows: February, $65,172.99; March, $56,069.31; and April, $58,860.96.

Mr. Yerkes reported that, for the portion of the budget year October 1–April 15, the receipts were 35.2 per cent of the estimated income for the year, as compared with 33.3 per cent (of actual) for the same period last year, and the disbursements to April 30, including an estimate of $10,000 for the latter part of April, amounted to 58.2 per cent, as compared with 56.6 per cent for the same period last year.

Upon recommendation of the Committee on Planning and Co-ordination, resulting from a request of the Meeting Committee, the directors approved a change in dates of the Midwest General Meeting, in Cleveland, Ohio, in 1951, to October 29–November 2.

Upon recommendation of the Committee on Planning and Co-ordination, based on comments previously considered and the preferences expressed by the vice-presidents of Districts 2, 4, 5, 6, and 7, and the chairman of the 1949 Midwest General Meeting Committee, the directors authorized a change in name of the Midwest General Meeting to "Fall General Meeting," with the under-

Lee Feted at University of California

Scene at a dinner in honor of AIEE President Everett S. Lee given by the University of California Society of Electrical Engineers, Berkeley, in the University Cafeteria. The dinner was held on April 7, 1949, during President Lee's recent Western tour

standing that it shall be held in the midwest area defined generally as from Cleveland to Omaha, Nebr., and from the Canadian border to the Gulf of Mexico.

Upon recommendation of the Committee on Planning and Co-ordination, the directors authorized the advancement to full committee status of the Metallic Rectifiers Subcommittee of the Committee on Chemical, Electrochemical, and Electrothermal Applications, and the separation of the Communication and Science Group into the "Communication Group" and the "Science and Electronics Group," with committees as listed elsewhere in this issue. Both actions will be effective at the beginning of the next administrative year, August 1, 1949.

The directors approved the following statements regarding registration fees at general and District meetings, submitted by the Committee on Planning and Co-ordination:

Guest speaker	No fee
Nonmembers presenting papers	Nonmember fee
Applicant for membership	Member fee
Attendance at meetings jointly sponsored with other societies	Fees as agreed upon beforehand with other society on either (a) each society charging its members according to its own rules, or (b) all in attendance being charged in accordance with AIEE rules. Identification to be agreed upon.
Attendance at social functions	No fee

AMENDMENTS

The following amendments to the bylaws were adopted upon recommendation of the Committee on Constitution and Bylaws:

Section 55 amended to read as follows:

> 55. Student Members enrolled under the provisions of these bylaws may purchase the current *Transactions* at the same price extended to members. This privilege may be withdrawn at any time by the Board of Directors.

Adopted the following new section, to be inserted between sections 70 and 71:

> 70A. The Committee on Education shall consist of not less than 20 members. This committee shall consider all matters related directly or indirectly to the education of those proposing to enter the profession of engineering, and the educational guidance of those already within the profession (exclusive of the direct sponsorship of subject matter within the scopes of technical committees). To this end, the committee shall focus its attention particularly upon problems that require the co-ordinated efforts of the engineering teacher, the practicing engineer, and industrial and governmental organizations.

After a discussion of the question of whether the activities of the Institute are to be confined to technical matters, for which it was organized, or efforts are to be made in general activities, the following resolution, offered by Chairman Walter C. Smith of the Committee on Constitution and Bylaws, was adopted:

> The Board of Directors, recognizing the equivocal position in which it is now placed, particularly in the eyes of our younger members, because of the fact that it is attempting, in a small way, with inadequate funds and personnel, to concern itself with some of the nontechnical activities of these members, and with a realization that such interests may much more efficiently be taken care of through another organization set up for that purpose, and recognizing the present difficulties of dealing with controversial matters, with consequent loss of prestige and possible splits in our membership, and recognizing the overwhelming importance of promoting in every possible way the technical interests of our members, HEREBY DECLARES that the American Institute of Electrical Engineers is strictly a scientific and educational organization, and that, in conformity with this declaration, it will be the policy of the Board of Directors to promote in every way the technical interests of our members to the exclusion of any other interests; also, that, where the Institute or any of its Sections is a joint member in another organization, it will be the policy of the Institute to interest itself in only such joint matters as relate to the technical activities of its members.

The directors then voted to refer the matter to a special committee with the assignment to stimulate discussion and consideration of this subject, both in the next meeting of the Section delegates and in the Sections, and to submit a report to the Board of Directors, based on such considerations, not later than the time of the Board of Directors meeting at the 1950 Winter General Meeting, with a progress report at each Board of Directors meeting in the meantime. The following special committee was appointed: M. D. Hooven, *Chairman;* J. L. Callahan; and R. T. Henry.

OTHER ACTIONS

A report of the AIEE-Institute of Radio Engineers Subcommittee on Joint Student Branches and a proposed model constitution were approved in principle, copies, after suitable revisions, to be sent to all Student Branch counselors with an invitation to submit their comments.

It was voted that the traveling expense allowance available to Branch chairmen for attending District Conferences on Student Activities be paid only to Branch chairmen who are Student Members of the AIEE.

Appointment by President Lee of the following Committee of Tellers, to canvass, count, and report on the ballots cast for the election of officers, was approved: J. W. Kingsbury, *chairman;* C. A. Clarke; R. L. Dhuy; F. H. Howell; Paul Kartluke; E. F. Katibah; and James M. Walsh.

A shortened application blank for the grade of Associate, giving less space for the record of experience, was adopted for use by Student Members.

The secretary reported briefly on plans for the engineering societies to co-operate with the National Military Establishment in making a survey of engineers of fully professional grade, the results of which would be highly useful in event of an emergency. Cooperation by the Institute is to involve the addressing of cards and questionnaires to Fellows and Members, with no direct expense to the Institute.

The secretary was directed to prepare and transmit to the Mercantile National Bank of Dallas a resolution expressing the appreciation of the Board of Directors of the facilities made available for this meeting of the directors and other courtesies.

Present at the meeting were

President—Everett S. Lee, Schenectady, N. Y.

Past President—B. D. Hull, Dallas, Tex.

Vice-Presidents—J. H. Berry, Norfolk, Va.; G. W. Bower, Haddonfield, N. J.; J. L. Callahan, New York, N. Y.; D. I. Cone, San Francisco, Calif.; I. M. Ellestad, Omaha, Nebr.; G. N. Pingree, Dallas, Tex.; E. W. Seeger, Milwaukee, Wis.; Victor Siegfried, Worcester, Mass.

Directors—W. L. Everitt, Urbana, Ill.; J. F. Fairman, New York, N. Y.; C. W. Fick, Cleveland, Ohio; J. M. Flanigen, Atlanta, Ga.; R. T. Henry, Buffalo, N. Y.; M. D. Hooven, Newark, N. J.; F. O. McMillan, Corvallis, Oreg.; J. R. North, Jackson, Mich.; Elgin B. Robertson, Dallas, Tex.; Walter C. Smith, Palo Alto, Calif.; E. P. Yerkes, Philadelphia, Pa.

Secretary—H. H. Henline, New York, N. Y.

S. H. Mortensen Addresses AIEE Philadelphia Section

The AIEE Philadelphia Section had as guest at its March meeting Dr. S. H. Mortensen, Chief Electrical Engineer of Allis-Chalmers Manufacturing Company of Milwaukee, Wis. The subject of Dr. Mortensen's address to several hundred members was, "Recent Developments in Turbogenerators."

This lecture covered the history and development of turbogenerators up to and including H_2 ventilated machines. Dr. Mortensen described materials now available, such as alloyed steels, nonmagnetic steels and materials, alloyed field copper, and insulation materials. Inspection methods, using radiograms and supersonic tests, and the mechanical problems involving centrifugal forces, critical speeds, short-circuit torques and stresses, fundamental and higher harmonic vibrations, temperature expansions and contractions, overspeeds, explosion-safe designs, stator and rotor ventilation, and kindred problems were described. Also, the relations between the physical generator dimensions and its rating, power factor, stability requirements as expressed by short-circuit ratio, operating volt, reactances, inductive interference, stray loss control, and so on, were developed.

Lantern slides showing construction details of air-cooled machines in capacities up to 174,000 kva were shown and were followed by a discussion of hydrogen as a ventilating medium illustrated by diagrams and curves showing relative outputs of air and hydrogen ventilated machines, and also for hydrogen-ventilated machines at different gas pressures. Design details were shown by sectional views of a 93,750-kva 3-phase 60-cycle 22,000-volt hydrogen-ventilated machine. A novel-type hydrogen shaft seal and simplified oil and gas controls were described. The latter consists of two U-tubes, one calibrated to indicate hydrogen purity and the other hydrogen pressure in generator. This, combined with an automatic hydrogen pressure regulator and signalling devices showing low and high hydrogen pressure in generator, constitutes the auxiliaries required for the hydrogen control. The shaft seal of the oil seal type takes the few gallons of oil it requires per hour directly and untreated from the turbine oil supply. The auxiliaries are limited to a detraining tank and a signalling system indicating high and low oil pressures. With this arrangement the station operator's duties are limited to checking hydrogen pressure and purity, the operation of signalling devices, and replacing empty hydrogen tanks.

In conclusion, standardization of 3,600-rpm generators was discussed and pictures of developed machines shown.

D. H. Lauder of the General Electric Company, C. T. Pearce of the Westinghouse Electric Corporation, J. W. Jones of the Philadelphia Electric Company, and R. W. Wilbraham of United Engineers and Constructors Inc., contributed to the discussion of this very informative meeting.

Mather of Harvard Delivers Steinmetz Memorial Lecture

Dr. Kirtley F. Mather, Professor of Geology, Harvard University, Cambridge, Mass., delivered the 22d annual Charles P. Steinmetz Memorial Lecture on Thursday, May 19, in Union College Memorial Chapel, Schenectady, N. Y. Dr. Mather's subject was "Natural Resources and Their Relation to Human Progress."

Founded in 1925 by friends of the great scientist as a "living memorial," the annual lectures honor both the memory of Steinmetz and the speaker selected to give the lecture. The lecture is sponsored by the AIEE Schenectady Section.

In delivering this lecture, Dr. Mather added his name to a long list of scientists, engineers, lecturers, and doctors similarly honored.

Dr. Mather is widely known as a geologist, lecturer, and author. As professor of geology in Harvard University, geologist in the United States Geological Survey, and consultant for oil companies, he has traveled widely and has added much to the store of geological knowledge concerning North and South America.

One of the leaders in the task of popularizing scientific knowledge, he is eminently successful in the presentation of technical information in an interesting and comprehensible manner, as evidenced by the great demand for his services on the lecture platform. He has given much thought to the impact of modern science upon religion and to the problems of the educational world. At the present time, he is especially concerned with the ways in which science can contribute to the intelligent organization of the postwar world on a just and durable basis.

His broadly human interests are indicated by the fact that as president of the Twentieth Century Club of Boston, Mass., he organized the Boston Center for Adult Education, a unique development in this increasingly important field. For many years he was the chairman of the Editorial Committee of the Scientific Book Club and at present he edits "The Scientist's Book Shelf" in *American Scientist*, the journal of the Society of the Sigma Xi. He is active in the Young Men's Christian Association where he has served as President of the National Council and is now a member of the Executive Committee of the National Board as well as a member of the World's Committee. He is president of the Foundation for Integrated Education and Educational Research Corporation.

1949 Lamme Medal Nominations Due December 1

Special attention is directed to the fact that the names of Institute members who are considered eligible for the AIEE Lamme Medal, to be awarded early in 1950, may be submitted by any member in accordance with section 1 of article VI of the bylaws of the Lamme Medal committee, as follows:

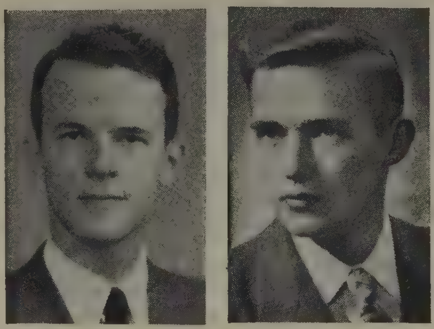
> The committee shall cause to be published in one or more issues of *Electrical Engineering*, or of its successors, each year, preferably including the June issue, a statement regarding the Lamme Medal and an invitation for any member to present to the secretary of the Institute by December 1, the name of a member as a nominee for the medal, accompanied by a statement of his "meritorious achievement" and the names of at least three engineers of standing who are familiar with the achievement.

Each nomination should give concisely the specific grounds upon which the award is proposed, and also a complete detailed statement of the achievements of the nominee, to enable the committee to determine its significance as compared with the achievements of other nominees. If the work of the nominee has been of a somewhat general character in co-operation with others, specific information should be given regarding his individual contributions. Names of endorsers should be given as specified in the foregoing quotation.

Fortescue Fellowships Awarded for Year 1949–50

The Charles Le Geyt Fortescue Fellowship Committee has awarded a fellowship for 1949–50 to Edward F. Koncel, Jr., for graduate study in electrical engineering at the Illinois Institute of Technology.

Mr. Koncel was born in Chicago, Ill., August 3, 1927. He received a degree of bachelor of science in electrical engineering from the Illinois Institute of Technology in January 1949. He is a member of Tau Beta Pi and Eta Kappa Nu, and has been a leader in many extracurricular activities.



James B. Woodford, Jr. (left) and Edward F. Koncel, Jr. (right)

His graduate research is to be devoted to an investigation of certain aspects of lightning phenomena on electric power transmission lines.

The committee also made an award for 1949–50 to James B. Woodford, Jr., in continuation of the fellowship awarded to him for graduate study at the Carnegie Institute of Technology during the year 1948–49. He is studying transition times in electronic switching.

Iowa Joint Student Branch Completes New Type Elections

The Iowa State College joint AIEE-Institute of Radio Engineers Student Branch has just completed a new style of biyearly elections, which may be unique in Student Branch history.

With more than 350 members, half of whom are Student Members, the Iowa State Branch long has believed that previous nomination and election methods lacked much in creating interest and enthusiasm among its members. In addition, the Branch found that nominations and elections held during a regular meeting did not wholly represent the membership; many of the members could not always attend. Consequently, the new method of nomination and election was instituted.

Instead of following the old style of taking nominations from the floor during the night of elections, there was an entire week for nominations. During this week men could be nominated by a petition signed by ten Branch members. As a nomination was received, the nominee's name was posted on a nomination board hanging in the entrance to the Electrical Engineering Building. Prior to nomination week, handbills were distributed among members urging them to nominate men for the new offices, and explaining the new nomination and voting procedure. Campaigning was encouraged and there was much activity, especially among the candidates.

On the last night of nomination week, a convention was held to eliminate the nominees to two for each office. Starting off with talks by the outgoing officers, the convention was a lively affair. Members stood and spoke for their candidates, and many nominees were asked to state their aims, intentions and past activities. Along with coffee, cokes, doughnuts, placards, campaigning, and demonstrations, nearly a hundred enthusiastic members staged a convention. After three hours of discussion and voting the ballot was complete.

Following the convention was an all-day election. The names of the candidates who survived the convention were placed upon the nomination board at the polls. By presenting his membership card each member received a ballot, and after marking it, placed it in a locked and sealed ballot box. Campaigning was also permitted at the polls, and as a result there were lots of attractions for prospective voters. So much interest was aroused that many students joined the Branch just to vote.

After eight hours of voting the ballots were counted at an open meeting of all members. In the presence of the Branch Counselor Chairman and Election Chairman, the counting was watched carefully by a score of anxious candidates and members. The voting was heavy—more than 130 ballots were cast, and it took two hours to complete the count. After it was over the results were posted on the Branch bulletin board.

The following Monday at the regular Branch executive meeting, the incoming and outgoing officers met together, and reports of the retiring officers and committee chairmen were submitted to the new chairman.

If other Branches are interested in trying a similar procedure, the Iowa State Branch has offered to give whatever aid it can.

Replies Sought to Questionnaire on Use of Air Break Switches

The AIEE Working Group on the Magnetization Characteristics of Transformers as They Affect Air Break Switches is attempting to determine operating practice in the United States with respect to the use of air break switches to interrupt magnetizing currents. Questionnaires have been distributed to more than 250 operating companies. At the same time, it is believed desirable to include the practice with respect to line and cable charging currents and load currents. It is hoped that sufficient information may be gathered to place some reasonable interrupting rating on horn gap switches.

The AIEE Standards state that an air switch has no interrupting rating but it is recognized that the switch occasionally must interrupt some small currents. This is not a very satisfactory situation, yet it is one which is difficult to improve. The working group believes that if sufficient information on present-day practice can be gathered, this information might be analyzed and presented in such a fashion as to show what is a reasonable performance to expect from a horn gap switch.

All replies will be analyzed and the results reported through AIEE for everyone's use. It is to your interest to help us in this work by furnishing the requested information. Please mail questionnaires to: J. J. Anderson, Jr., Secretary, AIEE Standards Committee, 33 West 39th Street, New York 18, N. Y.

COMMITTEE NOTES •

Editor's Note: This department has been created for the convenience of the various AIEE technical committees. It will include brief news reports of committee activities and proposed plans for such projects as special technical conferences and sessions at general meetings. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Changes Are Authorized in Technical Committee Setup

The following changes were authorized in technical committee and group setups by the AIEE Board of Directors at its meeting on April 20, 1949. The action of the Board of Directors was based on the recommendation of the Committee on Planning and Co-ordination, and is to be effective at the beginning of the next administrative year of the Institute, August 1, 1949.

COMMITTEE ON METALLIC RECTIFIERS

The Metallic Rectifiers Subcommittee has been advanced to full committee status by the Board of Directors.

At the September 24, 1948, meeting of the Technical Activities Subcommittee of the Planning and Co-ordination Committee, it was reported that an agreement had been reached for the transfer of the Metallic Rectifiers Subcommittee to the Committee on Electronic Power Converters from the Chemical, Electrochemical, and Electrothermal Applications Committee. However, it was pointed out that, since the Metallic Rectifiers Subcommittee had little in common with electric machinery and had much in common with electronics and basic sciences, perhaps the Metallic Rectifiers Subcommittee should be made a full technical committee within the Communication and Science Group. The matter was reviewed with the Metallic Rectifiers Subcommittee and this subcommittee looked with favor on the proposed elevation to full technical committee status; also favored this committee being put into the Communication and Science Group, with the understanding that it eventually would be in the Science and Electronics Co-ordinating Group. This now has been authorized.

As stated previously, the Committee on Metallic Rectifiers has been advanced to full technical committee with the following scope:

> Treatment of all matters in which the dominant factors are metallic rectifiers, particularly those dealing with the design, characteristics, and behavior of devices relating to "dry" type rectifiers, particularly those used in (usually) low-power applications, those used as modulators, demodulators, detectors, and instrument rectifiers, and point contact metallic rectifiers. If the field of application of such devices falls within the scopes of other technical committees, action with those committees may be joint.

SEPARATION OF THE COMMUNICATION AND SCIENCE GROUP

The Communication and Science Group has been separated by authority of the Board of Directors into the Communication Group, and the Science and Electronics Group.

At the October 18, 1948, meeting of the Committee on Planning and Co-ordination, it was voted to recommend to the Board of Directors that the Directors approve separation of the present Communication and Science Co-ordinating Committee into two new co-ordinating committees; one to be called the Communication Co-ordinating Committee, and the other the Science and Electronics Co-ordinating Committee. On October 19, 1948, the Board of Directors voted to refer this back to the Planning and Co-ordination Committee for further study.

The Technical Activities Subcommittee of the Committee on Planning and Co-ordination, after giving further study to this question, reported that the Committee on Communication looked with favor on the separation of the Communication and Science Co-ordinating Committee. A special subcommittee within the Committee on Communication was formed to work out the details of the proposed new co-ordinating committee. This subcommittee reported to the parent committee at its January 24, 1949, meeting, and the report was accepted unanimously with its recommendations. These recommendations were submitted by the Planning and Co-ordination Committee to the Board of Directors, who approved the following co-ordinating committee setup.

The Communication Co-ordinating Committee (Group) will consist of the following committees:

1. Committee on Wire Communication Systems
2. Committee on Radio Communication Systems
3. Committee on Aural Broadcasting Systems
4. Committee on Television Broadcasting Systems
5. Committee on Telegraph Systems
6. Committee on Communication Switching Systems
7. Committee on Special Communication Applications

The Science and Electronics Co-ordinating Committee (Group) will consist of the following committees:

1. Committee on Basic Sciences
2. Committee on Electronics
3. Committee on Nucleonics
4. Committee on Computing Devices
5. Committee on Instruments and Measurements
6. Committee on Electronic Power Converters
7. Committee on Metallic Rectifiers
8. Committee on Therapeutics

The proposed scopes for the new committees in the Communication Co-ordinating Committee will be as follows:

1. Committee on Wire Communication Systems. Covers wire transmission systems and associated apparatus as applied to open wire lines, land and submarine cables for providing telephone service and program transmission for aural and television broadcasting.

2. Committee on Radio Communication Systems. Covers radio communication systems of all kinds such as point-to-point systems including radio relay for telephone, telegraph, or television; and mobile systems for land, marine, or air-borne services.

3. Committee on Aural Broadcasting Systems. Embraces amplitude modulation and frequency modulation broadcasting stations, studio equipment, home radio receivers, and other facilities related to the broadcasting of aural programs for entertainment and instruction.

4. Committee on Television Broadcasting Systems. Comprises activities related to television broadcasting systems including studio and mobile pickup equipment, studio-transmitter links, television receivers, and other facilities associated with the technique of telecasting.

5. Committee on Telegraph Systems. Covers terminal and intermediate equipment or associated apparatus utilized in providing telegraph services over manual or automatic facilities. It includes also other forms of record communications such as facsimile, telephoto, teletypewriters.

6. Committee on Communication Switching Systems. Covers manual and automatic switching facilities and apparatus associated with communication systems.

7. Committee on Special Communication Applications. Handles those activities which do not logically fall within the scope of the other communication committees such as: electroacoustics, including wire and disk recording; railroad communications; and subjects related to materials and components used in communication apparatus.

The scopes for the committees in the Science and Electronics Group will remain the same with the exception of the Committee on Metallic Rectifiers, whose scope has been given in the foregoing.

Power Group

Committee on Power Generation. (*A. H. Frampton, Chairman; A. D. Caskey, Vice-Chairman; B. G. A. Skrotzki, Secretary*). Five technical sessions were sponsored during the past year, at which 13 technical and five conference papers were presented. Plans have been made to hold a technical conference on the subject of "Problems of Meeting Load Demands With Limited Reserve in Light of Maintenance and Forced Outages."

Subcommittee Activities. Plans are under way by the Prime Movers Subcommittee to organize a joint committee with the American Society of Mechanical Engineers to consider the problem of standardizing steam turbogenerators, 7,500-kw capacity and under. During the year the Speed Governing Specifications that had been on trial were recommended to be accepted for standard practice. A program of papers for the 1950 Winter General Meeting is being planned by the Station Design Subcommittee on "Centralized Control in Generating Stations." The working group on definitions of the Excitation Systems Subcommittee has produced about 12 definitions relating to excitation systems. These will be presented to American Standards Association Committee *C-42* for consideration and inclusion in their project on electrical definitions. Outage data on steam and hydro units collected under the auspices of the Edison Electric Institute have been published by the AIEE as a project of the Subcommittee on Application of Probability Methods. A bibliography on probability methods is being compiled as well as a collection of definition of terms, and a survey is under way of the load scheduling methods and spinning reserve practices being used by various utility systems in the United States. Plans are being made by the Pacific Coast Subcommittee to collect statistical data on electrical characteristics of recently installed hydro generators feeding extensive high-voltage long-distance transmission systems.

Committee on Carrier Current. (*L. F. Kennedy, Chairman; S. C. Bartlett, Vice-Chairman; E. W. Kenefake, Secretary*). During the past year the committee has sponsored two sessions at general meetings. Various projects are being followed actively or have been completed, as follows: preparation of a general-interest paper covering the status of carrier current in power system operation; survey of the methods of measurements at carrier frequency; collection of data on the carrier current characteristics of transmission lines and systems; assembling information on the carrier current characteristics of power equipment; appointment of a subcommittee to prepare information that would permit writing an application guide for carrier-current equipment; appointment of working group to obtain data as to the operating experience with carrier-current channels with the intention of publishing a committee report indicating the expected reliability of such channels; appointment of a subcommittee to study the requirements for tubes for carrier-current applications preparation and presentation of a report on the use of microwave equipment for relaying, telemetering, and supervisory control (this study will continue).

Industry Group

Committee on Electric Heating. (*G. W. Scott, Jr., Chairman; J. C. Handy, Vice-Chairman; L. M. Duryee, Secretary.*) Although the Electric Heating Committee has been functioning less than two years it has four very active subcommittees which hold frequent meetings on a regular schedule in various parts of the United States. P. H. Goodell's Subcommittee on Radiant Heating finds it necessary to set aside two days for its meetings, combining one or more plant visitations with the technical discussions. Lee Hynes conducts his Resistance Heating Subcommittee meetings somewhat more informally but every bit as constructively. Frequently a hotel room serves as the setting. In its work on radiation measurements, above 200 megacycles, R. M. Baker's subcommittee is conducting an extensive research program in various laboratories upon which to base its recommendations on this subject. W. C. Rudd's Subcommittee on Induction and Dielectric Heating is the oldest of the group sponsored by the Electric Heating Committee and the one from which the latter grew. For nearly four years it has been concentrating on the very important task of controlling interference from commercial induction and dielectric heating equipment.

Communication and Science Group

Committee on Basic Sciences. (*Walther Richter, Chairman; M. G. Malti, Vice-Chairman; N. S. Hibshman, Secretary.*) The Committee on Basic Sciences as well as its five subcommittees has been quite active during the past year. A sixth subcommittee has been added, on the Electrical Properties of Gases, under the chairmanship of Dr. J. Slepian, with Professor T. B. Jones acting as Vice-Chairman. At the Winter General Meeting in New York the committee unanimously passed on to the Standards Committee a proposal of Drs. Lewis and Reed concerning standardization of voltage notation.

The main committee, as well as the subcommittees, has sponsored sessions which have proved of interest to a great number of the members, as indicated by the excellent attendance at the meetings. As the program of the Swampscott meeting shows, this tradition will be upheld there: the main committee will sponsor a meeting with four papers, but of the greatest interest will undoubtedly be the Conference on Semiconductors and Transistors organized by the Subcommittee on Electrical Properties of Solids. The Subcommittee on Mathematics may be represented also at this meeting.

Committee on Computing Devices. (*Charles Concordia, Chairman; J. G. Brainerd, Vice-Chairman; Walter C. Johnson, Secretary.*) Activities of the Committee on Computing Devices so far have been to sponsor several sessions at AIEE meetings, including a session on analog computers at the last Winter General Meeting in New York, as well as several articles on computing machine developments in *Electrical Engineering.* A session is planned at the coming Summer General Meeting in Swampscott, Mass. Two major subcommittees have been formed, one on analog computers with Dr. E. L. Harder as Chairman, and one on Digital Computers with Dr. J. W. Mauchly as Chairman. Professor G. D. McCann is compiling a bibliography on computing machines, and Dr. W. H. MacWilliams, Jr., is co-ordinating with the IRE and ACM (Association for Computing Machinery) on nomenclature and definitions. Professor S. H. Caldwell maintains contact with the Instruments and Measurements Committee while C. Concordia (Chairman) and Dr. J. G. Brainerd (Vice-Chairman) are also members of the Basic Sciences Committee. Professor W. C. Johnson, Jr., is Secretary.

General Applications Group

Committee on Land Transportation. (*J. C. Aydelott, Chairman; H. F. Brown, Vice-Chairman; Leland W. Birch, Secretary*). The Land Transportation Committee is one of the older technical committees of the Institute and as such has sponsored papers dealing not only with such subjects as the various systems of electric traction for railway electrification, but the application of electricity and electrical engineering to all phases of railway transportation, trunk line, rapid transit or urban, and to all other forms of land transportation such as trolley coaches, and automotive equipment as well.

The program for the Swampscott meeting will be limited to one paper dealing with the use of diesel-electric locomotives in industrial plants, followed by a meeting of the committee.

Miami Section Holds First Annual Meeting

The new AIEE Miami Section held its first annual meeting on April 26, 1949, in the private dining room of the Seven Seas Restaurant in Miami, Fla. The meeting, at which the results of the first election of officers was announced, was attended by the 40 members shown here. Seated at the head table, left to right, are: C. V. Booth, J. P. Hanley, Directors; C. H. Summers, Chairman; Harvey F. Pierce, Chairman Advisory Board; W. T. Edwards, Secretary-Treasurer; Joseph Bronaugh, Director. E. F. Johnson, newly elected Vice-Chairman, is shown standing seventh from left

Papers under consideration for future meetings in the fall and winter include such diversified subjects as: "Why Different Cities Need Different Rapid Transit Equipment"; "Modern A-C M-U Car Equipment"; The Gas Turbine Locomotive"; "Centralized Traffic Control for Railroads"; and "Traction Equipment as Affected by Silicones."

Consideration also is being given by this committee to joint meetings with other interested engineering groups in the transportation field, such as the American Society of Mechanical Engineers and Electrical Section Association of American Railroads but these plans are as yet only in the formative stage. The committee at all times will welcome papers or suggestions from the Institute membership dealing with the application of electrical engineering to modern transportation problems.

Committee on Marine Transportation. (*Oscar A. Wilde, Chairman; Edgar C. Alger, Vice-Chairman; W. N. Zippler, Secretary.*) The Committee on Marine Transportation in meetings on January 28, 1949, and on April 8, 1949, reviewed comments on the December 1948 edition of AIEE Standard 45, "Recommended Practice for Electric Installations on Shipboard." The committee decided that an addendum will be prepared, covering any important corrections or revisions to that Standard, at the end of each fiscal year, for submission to the Standards Committee. The committee further began the preparation of draft proposals covering Standards on Marine Electric Propulsion Machinery and on implementation of the electrical sections of the 1948 International Convention for Safety of Life at Sea, including Marine Storage Battery Standards. This work was assigned to the committee by the Board of Directors of the Institute in accordance with the suggestion of the United States National Committee of the International Electrotechnical Commission. A. R. Gatewood of the American Bureau of Shipping represented the committee during the meeting of the IEC on Internation Standardization in London, England, in July 1948, when the two sections mentioned were assigned to the committee.

AIEE PERSONALITIES.....

R. H. Tapscott (A '18, F '29) has been elected to the recently created post of chairman of the board, Consolidated Edison Company of New York (N. Y.) Inc. Although he discontinues his duties as president of the organization, he will remain in his position of chief executive officer. The new chairman has been with the company since 1917 when he joined the New York Edison Company as assistant chief electrical engineer. Designated electrical engineer in 1925, he became vice-president of both the New York Edison and United Electric Companies in 1932. When these companies were merged into Consolidated Edison in 1936, he continued as vice-president. One year later, he was elected president and a trustee, and in 1942, he became chief executive officer. During the next four years, Mr. Tapscott served as president of New York Steam. At present, he is director of that company, as well as of all other system companies. Born in Brooklyn, N. Y., August 31, 1885, he was graduated from Union College in 1909 with the degree of bachelor of science in electrical engineering. Mr. Tapscott worked for the General Electric Company during the years 1909–1917. He has served on the following AIEE committees: Standards; Electric Machinery; Power Transmission and Distribution; Headquarters; Board of Examiners; Edison Medal; Finance; Executive; Co-ordination of Institute Activities; and Institute Policy.

H. R. Searing (A '20, F '30) has been elected president of the Consolidated Edison Company of New York (N. Y.) Inc., replacing **R. H. Tapscott.** Executive vice-president of the utility since 1944, the new president was employed by New York Edison in 1909 as a telephone operator. The following year, he was transferred to the test bureau, and in 1913, he went to the United Electric Company's meter department. Studying at Cooper Union at night, he received his electrical engineering degree in 1916. About this time, he was appointed cadet engineer. During World War I, he served as second lieutenant in the aviation section of the United States Signal Corps, and when he returned to the company, he was made assistant engineer. He advanced to superintendent, transmission and distribution department, in 1921, and to assistant electrical engineer within two years. In 1932, Mr. Searing was appointed general superintendent of distribution for both the New York Edison and United Electric Companies, and a year later, became general distribution manager. Named Consolidated Edison's engineer of operation in 1939, he was elected vice-president in charge of electric and gas operation and electric production in the next year. Gas production later was placed under his jurisdiction. Mr. Searing is a trustee or director of all system companies, and chairman of the board of the Subway Company. He is a native New Yorker, born May 3, 1895. The AIEE committees on which he has served are: Standards (ex officio); Safety Codes; Power Transmission and Distribution.

H. C. Forbes (A '25, F '44), formerly vice-president in charge of development and planning, has been elected executive vice-president, Consolidated Edison Company of New York (N. Y.) Inc. Joining the New York Edison Company in 1924, he became research engineer in 1928, and system engineer four years later. He was elected an assistant vice-president of Consolidated Edison in 1940, and a vice-president in 1945. He became a trustee of Consolidated in 1948, and he is also chairman of the system financial advisory committee and a vice-president and director of the New York Steam Company. Early this year, he was elected a director of the Westchester Lighting Company, and the Yonkers Electric Light and Power Company. A native of Colebrook, N. H., born February 21, 1898, he was graduated from the University of New Hampshire in 1921, and later received a master of science degree from the Massachusetts Institute of Technology. Prior to joining New York Edison, he was an instructor at the latter university for two years, and associated with the Western Electric Company. Mr. Forbes has served on the Power Transmission and Distribution Committee.

V. M. Montsinger (A '14, F '29), research engineer, power transformer engineering division, General Electric Company, Pittsfield, Mass., has retired after 39 years of service. A retirement party, held in his honor on April 27 in Pittsfield, was attended by more than 100 business friends and associates. Toastmaster for the affair was **Karl B.**

R. H. Tapscott

Volpe Studios

H. R. Searing

H. C. Forbes

V. M. Montsinger

McEachron (A ’14, F ’37), assistant manager of engineering, at the General Electric Company. Speakers were **F. F. Brand** (A ’10, F ’39), **I. H. Sclater** (A ’08, F ’27), **W. H. Cooney** (A ’24, M ’34), and **H. M. Jalonack** (M ’36). Presentation of a wrist watch to Mr. Montsinger was made by **H. S. Hubbard** (A ’23, M ’35), Chairman of the Pittsfield Section. The entertainment included a short skit showing incidents in the retiring engineer’s career. A native of High Point, N. C., born April 2, 1884, Mr. Montsinger received an electrical engineering degree from the University of North Carolina in 1909. After graduation, he joined the General Electric Company, as a test engineer at the Pittsfield plant. Until 1915, he worked as an experimental tester and transformer designer. After a brief assignment in San Francisco, Calif., as a sales specialist, he returned to design and development work at Pittsfield, where he remained until his retirement. Mr. Montsinger is noted for having developed practically all the formulas used in the United States for calculating the safe loading of transformers by temperature. Also, he was the first to publish the rule that the aging of class-*A* insulation doubles for each eight degrees increase in temperature. Author of 24 AIEE papers, some of the committees on which Mr. Montsinger has served are: Electric Machinery; Standards; Technical Program; Standards Council, American Standards Association (ASA); Electrical Standards Committee, ASA; the United States National Committee of the International Electrotechnical Commission; Lamme Medal; and Transformers. He was Chairman of the Pittsfield Section during the years 1932–33.

B. G. Jaqua (A ’49) has joined the Scott-Jaqua Company, Indianapolis, Ind., as vice-president and electrical engineer.

Paul Maurer (A ’33) and **P. B. Best, Jr.** (A ’40, M ’45), both of the Redmond Company, Owosso, Mich., have been advanced to new positions. Formerly director of engineering, Mr. Maurer was named vice-president in charge of engineering, while Mr. Best has been made vice-president in charge of series motor sales. Previous to joining the company in 1943, Mr. Maurer had been associated with the Hudson Motor Car Company and Bendix Aviation. Mr. Best has been with the Redmond Company since 1939.

E. M. Williams (A ’40, M ’47) has been appointed a full professor of electrical engineering at the Carnegie Institute of Technology, Pittsburgh, Pa. At the same time, **G. R. Patterson** (M ’35) was named an associate professor of electrical engineering. Mr. Williams, voted the outstanding electrical engineer for 1946 by Eta Kappa Nu, joined the Carnegie faculty in 1945 after service at Pennsylvania State College and with the Air Technical Service Command. He recently was awarded the President’s Certificate of Merit for his war work. Mr. Patterson was a member of the AIEE Instruments and Measurements Committee, 1942–4.

S. V. Hart (A ’43, M ’47), formerly with the Radio Corporation of America, Camden, N. J., has joined Industrial Electronics Incorporated, consulting laboratory and manufacturers, in Detroit, Mich., as chief engineer. In his new position, he will supervise the company’s projected expansion of the range of electronic applications to industrial processes. A 1939 alumnus of the Technical University of Vienna (Austria), Mr. Hart, during the four years following his graduation, did engineering work related to shipboard electric equipment, aircraft stress analysis, and power systems in Seattle, Wash., and San Francisco, Calif. Subsequently teaching physics and electrical engineering at eastern colleges, he became associated with the Radio Corporation of America in 1944, as an engineer in the industrial electronics section. Two years later, he transferred to the company’s aviation equipment engineering section.

H. J. Finison (A ’43, M ’47), former application engineer for the General Electric Company, Schenectady, N. Y., is the new assistant chairman of the electrical engineering department, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. Identified with General Electric’s industrial engineering division for five years, Mr. Finison, from 1940 to 1944, had been in charge of the test program on electrical-system performance on *B29* bombers, and had helped in the development of electric equipment for other military aircraft. Mr. Finison will supervise foundation work in the application of electrical systems in industrial control.

C. E. Smith (M ’44), until recently chief electrical engineer with the Taylor-Winfield Corporation, Warren, Ohio, has organized the Resistance Welder Engineering Company, in the same city. The new firm is a consulting engineering service, dealing with problems related to power supply, electronic control, and resistance welding. Mr. Smith also had been associated with the Westinghouse Electric Corporation, where he did design and development work on resistance-welding controls. He has been a member of the Electric Welding Committee for the last five years.

J. T. Lawson (M ’15) electrical operating engineer, has retired after 51 years of service with the Public Service Gas and Electric Company, Newark, N. J., and its predecessor companies. Since joining the organization in 1898 as a student engineer, he has held successively the positions of chief electrician, system operator, and assistant to the general superintendent of generation. Mr. Lawson served on the following committees: Protective Devices, 1914–16; Power Stations, 1918–19; Power Generation, 1924–27.

J. C. Meier (A ’44), has been appointed application engineer for the W. N. Matthews Company, St. Louis, Mo. Formerly, western editor of *Electrical World*, Chicago, Ill., Mr. Meier, in his new position, will specialize in field problems and apparatus applications. He also has been associated with Westinghouse Electric Corporation and Western Massachusetts Electric Company.

D. S. Young (A ’28, M ’36), for the past four years assistant general sales manager of the Canada Wire and Cable Company, Toronto, Ontario, has been appointed vice-president of Powerlite Devices, Limited, in the same city. Sixteen years, district engineer with the Anaconda Wire and Cable Company, Chicago, Ill., Mr. Young has had utility experience with the Detroit Edison Company, the Electric Bond and Share Company, and Winnipeg Hydro.

G. W. Brucker (A ’42) and **H. C. Steiner** (A ’32, M ’44) have been named to positions of designing engineers in the General Electric Company’s tube division, Schenectady, N. Y. Mr. Brucker has been with the company since 1922, and in his new capacity will work on power electronic equipment in the industrial and transmitting tube division. Mr. Steiner, who will be responsible for industrial-tube projects, joined General Electric 23 years ago. He has been a member of the Electronic Power Converters and the Electronics committees for the last two years.

O. J. Miller (M ’41) has been elected vice-president and general manager of the Duke Power Company, Charlotte, N. C. Connected with the utility since 1943, he became a director in 1946, and has been general manager since early last year. A practicing electrical engineer for 33 years, he has worked consecutively for E. W. Clark and Company, Columbus, Ohio, and the Tennessee Electric Power Company, and at one time, was manager of the transportation system in Nashville. In 1940, he joined the staff of the Commonwealth and Southern Corporation, Jackson, Mich.

H. S. Fitch (A ’18, M ’46) has been appointed vice-president of the West Penn Power Company, Pittsburgh, Pa. He will have full responsibility for the management of the power department, which was formerly under vice-president **A. N. Cartwright** (M ’41). Mr. Cartwright will continue as vice-president and hold his offices in subsidiary companies, rendering consulting and advisory service on technical matters related to engineering and construction. Mr. Fitch became associated with West Penn in 1913 as a system operating engineer. He has held the consecutive positions of assistant system operator, system operator, superintendent of electrical operations, and general superintendent of substations.

G. E. Bourne (A ’41), manager, special products section, apparatus department, Canadian General Electric Company, Toronto, Ontario, Canada, has been given general responsibility for the nucleonics activities of his department. He is responsible for the negotiations relating to the 70,000,000-electron-volt synchrotron to be installed at Queen’s University, Kingston, Ontario.

S. B. Williams (M ’37), until recently manager of customer relations, Sylvania Electric Products, Inc., New York, N. Y., has been named manager of public relations. Prior to joining Sylvania in 1947, he served as editor of *Electrical World*. He has been a member of the following AIEE committees: Publication; Lamme Medal; and the

Special Committee to Study Headquarters Equipment and Methods.

T. D. Thomas (A '39, M '42) is the new president of the Dallas Electric Club. Chief engineer with the Texas Power and Light Company, he served on the Industrial Power Applications Committee, 1944–46. **C. M. Mackey** (A '34, M '36), district manager, Westinghouse Electric Supply Company, was elected second vice-president of the Dallas group.

D. A. Lewis (M '35) has been appointed general operating superintendent of the New York State Electric and Gas Corporation, Binghamton, N. Y. Prior to joining the utility in 1925, he was connected with the Public Service Corporation of Northern Illinois. In his new capacity, Mr. Lewis will supervise the technical operations of the company on a state-wide basis.

A. D. Colvin (A '09, M '13), formerly executive vice-president, has been named president of the Connecticut Power Company His headquarters are changed from New London to Hartford. Before becoming Connecticut Power's executive vice-president in 1929, he had been associated with the Troy Gas Company, the Hartford Electric Light Company, and had taught for two years at Rensselaer Polytechnic Institute.

F. E. Sanford (A '28, F '46), has been engaged as a consultant by the Line Material Company, Milwaukee, Wis., to conduct a special engineering survey in connection with the company's products. Formerly director of research, Copper Wire Engineering Association, Chicago, Ill., he also has been identified with the Cincinnati Gas and Electric Company and *Electrical World*. Mr. Sanford has served on the Transmission and Distribution Committee, 1944–46, 1948–49.

J. T. Hood (A '35, M '42) has been elected president of the Professional Engineers of Oregon. He is with the General Electric Company in Portland, Oreg.

F. R. Kappel (M '43) has been elected vice-president in charge of the long lines department, American Telephone and Telegraph Company, New York, N. Y. His previous designation was assistant vice-president.

C. F. Monson (A '39), until recently assistant to the vice-president, has been advanced to assistant superintendent, Puget Sound Power and Light Company. He has been with Puget Power ten years.

A. M. Jacobs (M '18) has been appointed chairman of the Electricity Supply Commission, Johannesburg, Union of South Africa. For the past 21 years a member of the commission's board, he has done electrical engineering work in Europe, the United States, South America, Java, South China, and Japan. Succeeding Mr. Jacobs on the board is **J. T. Hattingh** (A '21, M '32), consulting electrical engineer to the commission. Mr. Hattingh was on the staff of the General Electric Company, Schenectady, N. Y., for some years, returning to South Africa in 1922.

E. R. Fosdick (A '26, F '40) has resigned as assistant director of power utilization for the Bureau of Reclamation to join the consulting engineering firm of H. Zinder, Washington, D. C. During his five years' service with the bureau, he helped to plan the power facilities for the Columbia and Missouri River basins. Previously, he had been on the staff of the Federal Power Commission.

P. S. Castner (A '47), formerly application engineer for load center and network transformers, Allis-Chalmers Manufacturing Company, Pittsburgh, Pa., has been promoted to assistant sales manager. He has been with the company since 1945.

C. B. Hart (A '47), until recently sales representative of the Allis-Chalmers Manufacturing Company in Boston, Mass., has been advanced to the post of New England region dealer supervisor. With Allis-Chalmers since 1945, Mr. Hart previously worked 17 years for the New England Power Company.

C. C. Nelson (M '36), formerly works manager, has become vice-president in charge of manufacturing at the Electric Machinery Manufacturing Company, Minneapolis, Minn. He has been associated with the company since 1928.

G. A. Palmer (A '44), since 1945, assistant meter engineer of the New England Electric Company, Boston, Mass., has been named meter engineer. He was a member of the Instruments and Measurements Committee, 1947–48.

Quentin Graham (A '39) has been elected a vice-president of the Elliott Company, Jeannette, Pa. He joined the company in 1944 as manager of the engineering department. In 1946, he was appointed manager of the Ridgeway Division.

C. C. Baltzly (M '23, F '43) to manager of the station operating department; **Herbert Estrada** (A '28, M '43) to general superintendent of the same department; and **J. L. Conner** (M '31) to assistant administrative engineer of the electric operations department, are new appointments recently announced by the Philadelphia (Pa.) Electric Company.

J. A. Becker (F '43) and **W. S. Gorton** (M'29) of the Bell Telephone Laboratories, Murray Hill, N. J., have received Army-Navy certificates of appreciation for work done under the Office of Scientific Research and Development. By applying thermistors to infrared detection, and through work in the field of accoustics, Becker and Gorton, respectively, earned their awards. **J. P. Maxfield** (M '23, F '27) consulting engineer, Los Angeles, Calif., and **W. B. Snow** (A '25, M '34), Kellex Corporation, New York, N. Y., were the recipients of similar certificates. Becker has been a member of the AIEE basic sciences committee for the last two years; Gorton served on the electrophysics committee 1930–31; and Maxfield belonged to the air transportation committee, 1940–41.

J. C. Jones (A '36, F '48) has been named assistant general superintendent of the Pacific Power and Light Company, Portland, Oreg. Previously, Jones had been associated with the Florida Power and Light Company, Miami, Fla., and before that, the Texas Power and Light Company.

C. A. Barbour (A '44) has been appointed district engineer in charge of the Montreal (Quebec, Canada) office of Eastern Power Devices, Limited. Barbour was formerly district office manager of D. M. Fraser Limited in the same city.

L. S. O'Roark (A '22) assistant director of publications, Bell Telephone Laboratories, New York, N. Y., has retired after 37 years with the organization. He is a graduate of the University of Kentucky, class of 1910. Work on telephone-cable loading problems, instrument testing, and helping to design the sound distribution system for the San Francisco Fair, occupied him during his first years of service in the Bell system. Subsequently joining the staff organization in 1919 as information manager, he later became general service manager and employment manager, successively. In 1925, soon after the formation of the company's publication department, he became one of its assistant directors. O'Roark belonged to the AIEE membership committee, 1924–27, and was its chairman, 1926–27.

Renee Dupuis (M '44), superintending engineer of operations, Beauharnois Light, Heat, and Power Company, Quebec, Canada, has been named to the board of the Quebec Hydro-Electric Commission. Educated at Laval and McGill Universities, and at the University of Nancy in France, Dupuis joined Canadian Westinghouse in 1924. Attached to the Shawinigan Water and Power Company, Three Rivers, Quebec, for five years, 1926–30, he subsequently joined the Quebec Power Company. In 1942, he became affiliated with Laval University, helping to launch the first specialized course in electrical engineering on the American continent which is taught in French. Five years later, he joined Beauharnois.

W. H. Croft (A '33, M '39), engineer with the Central Arizona Light and Power Company, Phoenix, is president of the recently organized Arizona Society of Professional Engineers.

W. N. Johnson (A '22, M '30), has been named vice-president in charge of operation of the Southern California Edison Company, Los Angeles, Calif. Johnson, who supervised the recent changeover of Edison territory from 50 to 60 cycles, joined the company in 1937 as manager of the Vernon City district. Previously, he had been employed for six years as the chief engineer of the department of water and power of the city of Vernon. With Southern California Edison, he was appointed superintendent of distribution in 1941, and four years later, assistant manager of operation.

E. W. Greenfield (A '34, M '37), supervisor, electrical laboratory, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y., has been elected vice-chairman of the Conference on Electrical Insulation, Division of Engineering and Industrial Research, National Council Research, for the term, 1949–50. After receiving an electrical engineering degree in 1929 from Johns Hopkins University Greenfield worked as research associate for four years at his alma mater, following which period, he received his doctorate. Joining Anaconda in 1935, as a cable research engineer, he became supervisor of the electrical laboratory five years later. He has specialized in the development of high-voltage electrical insulation, dielectric measurement apparatus, and high-frequency power transmission. A member of the American Society for Testing Materials and the American Physical Society, Greenfield is at present serving on the AIEE electronics committee.

F. O. McMillan (A '14, F '32), a director of the AIEE and head of the electrical engineering department, Oregon State College, Corvallis, has been elected the first president of the Mid-Williamette Section of the Professional Engineers of Oregon. McMillan has served on the following AIEE committees: Student Branches, 1930–36 and 1948–49; electrophysics, 1934–37; research, 1934–36 and 1938–41; transfers, 1936–42 (chairman 1939–41); education, 1939–40; and technical program, 1948–49.

A. H. Grimsley (A '16, M '21), chief of the consolidation section, Federal Power Commission, Washington, D. C., has retired after 15 years' service with that organization. Engaged in engineering work for more than 35 years, the first 14 years of Grimsley's career were spent in the civil and mechanical fields, principally railroad and mill construction. From 1908 to date, he has specialized in electrical engineering, some of the positions that he held being: superintendent of Kanawa Water and Light Department, Charleston, W. Va., vice-president and general manager of Virginia-Western Power Company, Clifton Forge, Va., vice-president and general manager of the Virginia Public Service Company, Charlottesville, and vice-president of the General Engineering and Management Company, New York, N. Y. Some of Grimsley's achievements include the design of steam and hydroelectric generating plants, high-tension transmission lines, and substation and distribution systems. A Member for Life of the Institute, Mr. Grimsley also belongs to the National Electric Light Association.

Harold Lyons (M'47), chief of the microwave standards laboratory of the National Bureau of Standards, Washington, D. C., has been presented the Arthur S. Fleming Award by the Washington Junior Board of Commerce for his outstanding government service. According to the chamber's citation, Lyons was responsible for four general scientific developments during 1948, the most important of which was the construction of the atomic clock. This latter instrument measures time with greater accuracy than any known device, astronomical or otherwise. A 1933 alumnus of the University of Buffalo, Lyons received his master and doctor degrees, in 1935 and 1939 respectively. Joining the Naval Research Laboratory in the latter year, he came to the National Bureau of Standards in 1941, and was appointed to his present position five years later. A member of the American Physical Society, Lyons at present is serving on the AIEE instruments and measurements committee.

OBITUARY • • • • • •

Joseph Henry Tracy (A '08, M '12), formerly with the Electric Storage Battery Company, Philadelphia, Pa., and a resident of Jenkintown, Pa., died March 15, 1949. Born December 23, 1873, in Durham, Conn., he attended the Sheffield Scientific School of Yale University. Following his graduation in 1896, he joined the Hartford (Conn.) Electric Light Company. Three years later, he began an association with the Electric Storage Battery Company, which was terminated by his retirement in 1942. Mr. Tracy held a variety of positions with the company, including that of chief engineer, and at one time was manager of the Philadelphia branch. A member of the AIEE Sections committee, 1916–17, he served as chairman of the Philadelphia Section, 1915–16. Mr. Tracy was a Member for Life of the Institute.

William Levi Hoffman (M '41), electrical engineer of Seattle, Wash., died February 7, 1949. Born in Chippewa Falls, Wis., April 14, 1875, he was graduated from Cornell University in 1898. During the next five years, he worked successively for the Bethlehem (Pa.) Steel Company, the Western Electric Company, Chicago, Ill., and the Westinghouse Electric Corporation, East Pittsburgh, Pa. Moving to Tacoma, Wash., in 1903, Hoffman became a member of the engineering staff which built the city's Nisqually power plant. Later, he joined the Stone and Webster Engineering Corporation, where he assisted in the construction of Northwestern Electric's Condit water-power plant. In 1914, Mr. Hoffman became identified with the Puget Sound Power and Light Company, Seattle, Wash., continuing with the utility until his retirement in 1945. He was a Member for Life.

Albert J. Kuester (A '46), electrical designer, Vern E. Alden Company, Chicago, Ill., died February 22, 1949. A native of Chicago, he was born May 23, 1906. For nearly a score of years, beginning in 1924, he was an electrical draftsman, being employed by the following Chicago firms: Pullman-Standard Car Manufacturing Company; Public Utility Engineering and Service Corporation; and Carnegie-Illinois Steel Corporation. While working, Mr. Kuester attended engineering school at night, and in 1943, he became an electrical designer with Sargent and Lundy. Two years later, he joined Vern E. Alden, where he was named chief electrical designer and assisted in the design of electric power, control, lighting, and communication installations for power plants and substations.

Arthur Edward Appleyard (A '96, M '21), vice-president, American Black Granite Company, Ashland, Wis., died recently. A native of Lincoln, England, he was born June 29, 1867. In 1888, he joined the Elliott Falls Electric Light Company, South Natick, Mass. During the years 1890–97, he was manager of the Natick (Mass.) Gas and Electric Company and engineer for the Framingham (Mass.) Electric Light Company. For the next several years, he was associated with various railways in the Midwest, assisting in the construction of electric-railway equipment and high-tension transmission lines. In 1907, he became vice-president and general manager of the Ashland (Wis.) Light, Power and Street Railway Company, and two years later he assumed similar duties with the Ironwood and Bessemer Railway and Light Company. Subsequently, he became president of the British Columbia and Alberta Power Company. In later years, he helped to build up the utility system which is now the Lake Superior District Power Company and to organize the American Black Granite Company, which supplied the black granite for Radio City in New York, N. Y., and the Marshall Field Building in Chicago, Ill. Mr. Appleyard was a Member for Life of the Institute.

Lester Andrew Magraw (A '07, M '13), president of the Central Illinois Public Service Company, Springfield, died March 25, 1949. Identified with the Illinois utility since 1932, Mr. Magraw began his engineering career in the manufacturing branch of the electrical industry, joining the Crocker-Wheeler Company, Ampere, N. J., subsequent to his graduation from Worcester Polytechnic Institute in 1905. Two years later, he became associated with the Westinghouse Electric and Manufacturing Company. His work there dealt with lightning arresters and high-voltage equipment. In 1911, he joined the Central Georgia Power Company as chief engineer, and the following year, he became chief engineer with the Macon Railway and Light Company. During the next several years, he held the various positions of treasurer, general manager, director, and vice-president. He became vice-president and general manager of the South Carolina Power Company, Charlotte, in 1928, and president two years later. A native of Springfield, Mass., born May 7, 1883, Mr. Magraw was a member of the board of directors of the Edison Electric Institute, and a member of the American Society of Mechanical Engineers. He was a Member for Life of the AIEE.

MEMBERSHIP • •

Recommended for Transfer

The board of examiners at its meeting of April 21, 1949, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Fellow

Canavaciol, F. E., prof. of elec. engg., Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Grimsley, A. H., retired, Hotel Jefferson, Clifton Forge, Va.
Harvey, H. F., Jr., elec. engr., Newport News Shipbuilding & Drydock Co., Newport News, Va.
Lichtenberg, Colonel C., asst. to works mgr., General Elec. Co., Ft. Wayne, Ind.
Sasscer, C. D., elec. engr., dept. Army Office, Chief of Engineers, Washington, D. C.
Schmidt, M. L., designing engr., FHP motor divs., General Electric Co., Ft. Wayne, Ind.
Summers, C. M., engr., chge. Ft. Wayne lab., General Electric Co., Ft. Wayne, Ind.
Vogel, F. J., prof., Illinois Institute of Technology, Chicago, Ill.
Werner, C. J., chief engr., delco products div., General Motors Corp., Dayton, Ohio.
Xenis, C. P., division engr., Consolidated Edison Co. of N. Y., Inc., New York, N. Y.

10 to grade of Fellow

To Grade of Member

Allison, D. M., elec. engr., Westinghouse Electric Corp., St. Louis, Mo.
Andrews, F. A., chief operator, Consolidated Gas Electric Light & Power Co. of Baltimore, Md.
Ballard, R. G., division engr., aeronautical instrument engg. div., General Electric Co., West Lynn, Mass.
Barron, J. P., elec. engr., Dallas Power & Light Co., Dallas, Tex.
Boisseau, A. C., managing engr., power circuit breaker div., General Electric Co., Philadelphia, Pa.
Bowers, B. N., high voltage bushing engg. div., General Electric Co., Pittsfield, Mass.
Brown, C. B., elec. engr., Bureau of Reclamation, Billings, Mont.
Cachat, J. F., commercial engr., The Ohio Crankshaft Co., Cleveland, Ohio
Cantrell, S. W., asst. substation designer, Pacific Gas & Electric Co., Oakland, Calif.
Christison, D. C., elec. engr., appraisal dept., Kimberly-Clark Corp., Neenah, Wis.
Croy, R. J., chief elec. engr., W. C. Kruger & Co., Los Alamos, N. Mex.
Dickerhoff, J. F., supervisor of commercial & industrial lighting, Long Island Lighting Co., Mineola, N. Y.
Dingler, R. D., executive chief electrician, Monolith Portland Cement Co., Laramie, Wyo. (Monolith, Calif.)
Dupuis, H. P., elec. engr., The Commonwealth & Southern Corp., Jackson, Mich.
Finzi, L. A., assoc. prof. elec. engg., Carnegie Institute of Technology, Pittsburgh, Pa.
Fontaine, C. B., Jr., asst. division engr., General Electric Co., Lynn, Mass.
Fowles, G. A., sales mgr., plastic materials, B. F. Goodrich Chemical Co., Cleveland, Ohio.
Freed, I. F., asst. to supt., power transmission stations, Consolidated Gas Electric Light & Power Co., of Baltimore, Md.
Gager, F. M., section head, radio div. III, Naval Research Laboratory, Washington, D. C.
Gates, L. A., elec. engr., Moloney Electric Co., St. Louis, Mo.
Gibbons, J. P., elec. engr., Goodman Manufacturing Co., Chicago, Ill.
Griffith, D. A., asst. to general mgr., Allis-Chalmers Mfgr. Co., Pittsburgh, Pa.
Grim, C. D., elec. engr., Gilbert Associates, Inc., Reading, Pa.
Herman, C. J., design engr., General Electric Co., Ft. Wayne, Ind.
Hill, R. C., group leader, University of California, Los Alamos Scientific Lab., N. Mex.
Hipp, J. E., asst. supt., Consolidated Gas Electric Light & Power Co., Baltimore, Md.
Hobart, E. A., president, The Hobart Brothers Co., Troy, Ohio
Hoff, H. B., transmission engr., Ohio Bell Telephone Co., Cleveland, Ohio
Jones, R. W., assoc. prof., Northwestern Technological Institute, Evanston, Ill.
Kalb, J. W., development engr., General Electric Co., Pittsfield, Mass.
Lawrence, L. E., elec. engr., Allen-Bradley Co., Milwaukee, Wis.
Lawrence, N. S., instructor, elec. engg., Columbia University, New York, N. Y.
Lewis, C. P., elec. engr., The Clark Controller Co., Cleveland, Ohio
Mack, C. D., elec. maintenance engr., San Diego Gas & Electric Co., San Diego, Calif.
Meiklejohn, W. H., development engr., General Electric Co., Lynn, Mass.
Miller, S. C., transmission & outside plant engr., The Chesapeake & Potomac Telephone Co., Baltimore, Md.
Muller, C. R., project engr., Federal Telecommunication Labs., Inc., Nutley, N. J.
Murray, J. E., owner, J. E. Murray & Co., North Kansas City, Mo.
Nelson, J. M., senior engr., Seattle City Light, Seattle, Wash.
Opitz, F. M., electrical consultant, 2517 N. Charles St., Baltimore, Md.
Patten, I. A., general supt., Lynn Gas & Electric Co., Lynn, Mass.
Ramsey, A. K., Jr., assoc. prof. elec. engg., Louisiana State Univ., Baton Rouge, La.
Richardson, C. N., consultant, Youngstown, N. Y.
Robbins, F. D., instructor, elec. engg., University of Washington, Seattle, Wash.
Rodgers, J. M., electrical machinery engr., delco products div., General Motors Corp., Dayton, Ohio
Solberg, W. O., development engr., General Electric Co., Pittsfield, Mass.
Somerville, G. G., section head, laboratory, General Electric Co., Pittsfield, Mass.
Spaulding, L. R., elec. engr., Bonneville Power Administration, Vancouver, Wash.
Stoughton, M. L., district mgr., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Stubblebine, C. A., industrial power engr., Georgia Power Co., Atlanta, Ga.
Terwilliger, D. D., research engr., The Glenn L. Martin Co., Baltimore, Md.
Thompson, G. R., elec. engr., Eastman Kodak Co., Rochester, N. Y.
Tidd, W. H., member technical staff, Bell Telephone Labs., Inc., New York, N. Y.
Tucker, W. M., elec. engr., U. S. Naval Research Laboratory, Washington, D. C.
Turner, W. R., graduate student, California Institute of Technology, Pasadena, Calif.
Underhill, B. B., asst. prof. engg. research, Pennsylvania State College, State College, Pa.
Uptegraff, R. E., Jr., chief engr., R. E. Uptegraff Mfg. Co., Scottdale, Pa.
Warren, C. T., elec. engr., The Pure Oil Co., Smith's Bluff Refinery, Nederland, Tex.
Warren, M., Jr., asst. superintendent, Power Aluminum Co. of America, Alcoa, Tenn.
Westheimer, E. G., exchange engr., Southwestern Bell Telephone Co., Houston, Tex.
Willey, R. E., transmission & protection engr., Northwestern Bell Telephone Co., Minneapolis, Minn.
Wilson, D. G., chairman, dept. of elec. engg., University of Kansas, Lawrence, Kans.
Wrensch, B. E., elec. engr., Stearns Magnetic Mfgr. Co., Milwaukee, Wis.

63 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before June 21, 1949, or August 21, 1949, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Abbott, H. F., Beauharnois Light, Heat & Power Co., Beauharnois, Quebec, Canada
Bentley, E. F., G & W Elec. Specialty Co., Chicago, Ill.
Black, G. A., Duke Power Co., Greenville, S. C.
Black, G. F., Rome Cable Corp., San Francisco, Calif.
Browning, D. M., Arizona Wholesale Supply Co., Inc., Phoenix, Ariz.
Cisneros, S. C., Messrs. Palomino & Mora, Mexico, Federal District, Mexico
Cowan, J. W., Hatzel & Buehler Inc., New York, N. Y.
Damm, G. E., Hyre Elec. Co., Chicago, Ill.
Diehl, F. D., McPherson Water & Elec. Dept., McPherson, Kans.
Edwards, F. W., Duke Power Co., Charlotte, N. C.
Fahse, K. A., International Harvester Co., Chicago, Ill.
Gayek, H. W., General Elec. Co., Schenectady, N. Y.
Gishlick, H. E., The Austin Co., New York, N. Y.
Gretz, C. B., Chesapeake & Potomac Tel. Co., Washington, D. C.
Grimm, G. A. (re-election), Florida Power Corp., St. Petersburg, Fla.
Gupta, O. P., Dalmia Cement Ltd., New Delhi, India
Jennings, P. D. (re-election), Puget Sound Power & Light Co., Seattle, Wash.
Jha, R., M.E.S., E.S.D. (M), Kankinara, India
Jones, L. E., Industrial Elec. Service, Los Angeles, Calif.
Keil, C., British Thomson-Houston Co., Ltd., Rugby, England
Kintner, E. G., Jr., Westinghouse Elec. Corp., Baltimore, Md.
Lummis, J., So. California Edison Co., Los Angeles, Calif.
Maloney, J., 111 Queen Street, Port of Spain, Trinidad
Marcus, A., Marcus Transformer Co., Inc., Hillside, N. J.
Meszar, J., Bell Tel. Lab., Inc., New York, N. Y.
Mickley, N. E., Cleveland Elec. Illuminating Co., Cleveland, Ohio
Myers, O., Bell Tel. Labs., Inc., New York, N. Y.
Papp, A. E., G & W Elec. Specialty Co., Chicago, Ill.
Patell, D. P., Lt. R.I.N.V.R., Associated Cement Cos., Ltd., Bombay, India
Patrick, W. P., General Elec. Co., Schenectady, N. Y.
Potter, W. F., New England Tel. & Tel. Co., Boston, Mass.
Priestley, W. K., U. S. Rubber Co., Bristol, R. I.
Rao, H. N., Indian Institute of Science, Bangalore, India
Sinisi, B. J., Marcus Transformer Co., Inc., Hillside, N. J.
Speer, J. L. D., Jr. (re-election), Bell Tel. Co. of Baltimore City, Baltimore, Md.
Springston, C. D., Ohio Edison Co., Akron, Ohio
Stanton, R. S., Smith, Hinchman & Grylls, Inc. of Detroit, Navy Dept., Washington, D. C.
Stewart, H. E., Cleveland Elec. Illuminating Co., Cleveland, Ohio
Swaroop, S., M/S Aluminum Corp. of India, Ltd., Jaykaynagar, Burdwan, India
Taft, G. L., Pacific Power & Light Co., Astoria, Oreg.
Taylor, B. M., San Diego City Schools, San Diego, Calif.
Taylor, D. W., N. Y. State Elec. & Gas Corp., Elmira, N. Y.
Thompson, A. R., Bell Tel. Labs., New York, N. Y.
Wojcikowski, J. S., Hydro-Elec. Power Comm., Toronto, Ontario, Canada

44 to grade of Member

To Grade of Associate

United States, Canada, and Mexico

1. NORTH EASTERN

Adams, F. A., General Elec. Co., Schenectady, N. Y.
Baldwin, G. H., General Elec. Co., Schenectady, N. Y.
Banks, E. C., Boston Edison Co., Somerville, Mass.
Bassett, M. O., General Elec. Co., Schenectady, N. Y.
Baumann, F. W. (re-election), General Elec. Co., Schenectady, N. Y.
Belyea, R. C., General Elec. Co., Schenectady, N. Y.
Białous, J. L., General Elec. Co., Schenectady, N. Y.
Brown, T. E., Boston Edison Co., Boston, Mass.
Bushman, R. N., General Elec. Co., Schenectady, N. Y.
Davis, S., General Elec. Co., Schenectady, N. Y.
Derr, E. M., General Elec. Co., Pittsfield, Mass.
Deutschle, F. J., Great Lakes Carbon Corp., Niagara Falls., N. Y
Dovi, A. C., Jackson & Moreland, Boston, Mass.
Dunigan, F. P., Jr., General Elec. Co., Worcester, Mass.
Eaton, W. R., General Elec. Co., Schenectady, N. Y.
Ellis, W. H., General Elec. Co., Schenectady, N. Y.
Fenoglio, P.,General Elec. Co., Pittsfield, Mass.
Ferguson, J. A., Power Bureau Public Service Comm., Albany, N. Y.
Gibbard, W. G., General Elec. Co., Schenectady, N. Y.
Gibson, T. K., General Elec. Co., Schenectady, N. Y.
Gould, C. L., General Elec. Co., Schenectady, N. Y.
Graves, W. L. O., General Elec. Co., Schenectady, N. Y.
Grup, H. W., General Elec. Co., Schenectady, N. Y.
Hofmann, L. H., U. S. Rubber Co., Bristol, R. I.
Hogue, L. J., General Elec. Co., Schenectady, N. Y.
Hubbard, A. G., General Elec. Co., Schenectady, N. Y.
Hunter, W. A., Jr., General Elec. Co., Schenectady, N. Y.
Johnsen, R. O., General Elec. Co., Schenectady, N. Y.
Keenan, W. M., Cornell Univ., Ithaca, N. Y.
Kendall, A., N. Y. State Elec. & Gas Corp., Elmira, N. Y.
Kesler, R. W., International General Elec.Co., Schenectady, N. Y.
Koerner, T. K., General Elec. Co., Schenectady, N. Y.
Kronick, M., General Elec. Co., Schenectady, N. Y.
Leftwich, R. F., General Elec. Co., Schenectady, N. Y.
Lemmond, C. Q., General Elec. Co., Schenectady, N. Y.
Levine, M. P., Univ. of Massachusetts, Amherst, Mass.
McComb, R. D. (re-election), General Elec. Co., Schenectady, N. Y.
McElligott, J. E., General Elec. Co., Schenectady, N. Y.
McLeod, A. L., Jr., General Elec. Co., Schenectady, N. Y.
Morgan, H. I., General Elec. Co., Schenectady, N. Y.
Nelson, H. V., General Elec. Co., Schenectady, N. Y.
Neslin, M. A., General Elec. Co., Schenectady, N. Y.
Noorigian, E., New England Power Service Co., Boston, Mass.
Owens, J. I., Jr., General Elec. Co., Schenectady, N. Y.
Pease, R. B., General Elec. Co., Schenectady, N. Y.
Peterson, G. R., General Elec. Co., Schenectady, N. Y.
Peterson, R. E., Monitor Controller Co., Braintree, Mass.
Reeb, C. W., General Elec. Co., Schenectady, N. Y.
Rodgers, W. M., Jr., General Elec. Co., Schenectady, N. Y.
Sachse, E. S., Univ. of Massachusetts, Amherst, Mass.
Shamblen, R. H., General Elec. Co., Pittsfield, Mass.
Schissel, P. O., General Elec. Co., Schenectady, N. Y.
Schoch, K. F., General Elec. Co., Schenectady, N. Y.
Schrom, E. C., General Elec. Co., Schenectady, N. Y.
Schultz, C. W., Univ. of Connecticut, Storrs, Conn.
Shedd, R. D., General Elec. Co., Schenectady, N. Y.
Sinclair, C., General Elec. Co., Schenectady, N. Y.
Smith, W. W., Univ. of Massachusetts, Amherst, Mass.
Soper, L. N., Walter J. Rider Co., Binghamton, N. Y.
Staake, D. B., Norwich Univ., Northfield, Vt.
Strunk, C. L., General Elec. Co., Schenectady, N. Y.
Sykes, C. A., General Elec. Co., Schenectady, N. Y.
Thompson, B H., General Elec. Co., Schenectady, N. Y.
Tomsha, E. C., General Elec. Co., Schenectady, N. Y.
Travis, W. C., General Elec. Co., Schenectady, N. Y.
Ulgur, M. M., General Elec. Co., Schenectady, N. Y.
Updyke, G. W., N. Y. State Elec. & Gas Corp., Elmira, N. Y.
Utting, R. P., General Elec. Co., Schenectady, N. Y.
Wagner, G. H., Asplundh Tree Expert Co., Binghamton, N. Y.
Walker, W. W., General Elec. Co., Schenectady, N. Y.
Wasserman, M. S., General Elec. Co., Schenectady, N. Y.
Wegman, E. C., General Elec. Co., Lynn, Mass.
Witt, K. C., General Elec. Co., Schenectady, N. Y.
Wood, D. E., General Elec. Co., Schenectady, N. Y.

2. MIDDLE EASTERN

Abernathy, W. S., Potomac Elec. Power Co., Washington, D. C.
Bell, R. T., Pennsylvania Elec. Co., Erie, Pa.

Benis, B., Cleveland Elec. Illuminating Co., Cleveland, Ohio
Botdorf, G. E., Jack & Heintz Precision Industries, Inc., Bedford, Ohio
Brooks, J. F., Natl. Bureau of Standards, Washington, D. C.
Casto, V. K., Appalachian Elec. Power Co., Cabin Creek, W. Va.
Cole, J. C., Jr., Delaware Rayon Co., New Castle, Dela.
Daniels, W. L., United Engrs. & Constructors, Inc., Philadelphia, Pa.
D'Ascenzo, A. J., Philadelphia Elec. Co., Philadelphia, Pa.
Flora, W. C., Jr., Bethlehem Steel Co., Sparrows Point, Md.
Gall, A. F., Charleston Elec. Supply Co., Charleston, W. Va.
Gibson, J. W., 3626 Piedmont Rd., Huntington, W. Va.
Heiss, F. S. D., The Bell Tel. Co. of Pennsylvania, Philadelphia, Pa.
Humphreville, T. N., Westinghouse Elec. Corp., Cleveland, Ohio
Kapp, C. G., Reliance Elec. & Engg. Co., Cleveland, Ohio
Keppel, L. P., Meadville Tel. Co., Meadville, Pa.
Konold, W. G., Potomac Elec. Power Co., Washington, D. C.
Koontz, H. W., The Notnac Mfg. Co., Canton, Ohio
Lasswell, P. M. (re-election), USAF, Air Materiel Command, Wright Field, Dayton, Ohio
Love, A. N., Jr., Guyan Machinery Co., Logan, W. Va.
Maley, L. E., Brown Instrument Co., Philadelphia, Pa.
McEntire, F. E., Jr., Cmdr., USN, The Johns Hopkins Univ., Baltimore, Md.
Nosko, V. A., Cleveland Elec. Illuminating Co., Cleveland, Ohio
Noyes, T. M., 613 Benninghaus Rd., Baltimore, Md.
Oberheim, E. F., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Patnaik, H., c/o Education Dept., Embassy of India, Washington, D. C.
Scheu, C. F., Jack & Heintz, Inc., Bedford, Ohio
Showman, J. M., Cleveland Elec. Illuminating Co., Cleveland, Ohio
Sofian, M., Philadelphia Elec. Co., Philadelphia, Pa.
Stasik, E. F., Westinghouse Corp., Baltimore, Md.
Suarez, J. M., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Swam, R. E. S., Swam Elec. Co., Inc., Hanover, Pa.
Tayman, A. C., Potomac Elec. Power Co., Washington, D. C.
Workman, A., Appalachian Elec. Power Co., Cabin Creek, W. Va.

3. New York City

Auslander, S. H., Westinghouse Elec. Corp., New York, N. Y.
Boselli, G. V., Bendix Aviation Corp., Teterboro, N. J.
Cavalconte, C. C., Manhattan College, New York, N. Y.
Christie, A. J., Consolidated Edison Co., New York, N. Y.
Driscoll, E. G., Phelps Dodge Copper Products Corp., Yonkers, N. Y.
Florman, M., Consumer's Union of U. S., New York, N. Y.
Heller, F., Burndy Eng. Co., New York, N. Y.
Johnson, F. H., Federal Tel. & Radio Corp., Clifton, N. J.
Kearney, J. J., Jr., Ebasco Services, Inc., New York, N. Y.
McSweeney, J. T., T. Frederick Jackson, Inc., New York, N. Y.
Murray, H. J., Board of Transportation, New York, N. Y.
Parry, J. P., Westinghouse Elec. Internatl. Co., New York, N. Y.
Platter, A. V., I.B.M. Corp., Poughkeepsie, N. Y.
Retallack, R. L., American Gas & Elec. Service Corp., New York, N. Y.
Shamah, M. A. A., International General Elec. Co., New York, N. Y.
Stone, R. M., Hazeltine Electronics Corp., Little Neck, N. Y.

4. Southern

Ashe, R. C., Georgia Power Co., Atlanta, Ga.
Branson, W. S., General Elec. Supply Corp., Louisville, Ky.
Burdeshaw, T. A., Southern States Equipment Corp., Hampton, Ga.
Burgin, E. C., Jr., TVA, Chattanooga, Tenn.
Castles, J. F., S. C. Elec. & Gas Co., Columbia, S. C.
Cocke, R. P., Jr., N. C. State College, Raleigh, N. C.
Elam, F. P., TVA, Chattanooga, Tenn.
Fortier, R. E., Louisiana Power & Light Co., New Orleans, La.
Howard, E. E., Braddock Light & Power, Alexandria, Va.
Jenkins, F. A., Duke Powder Co., Charlotte, N. C.
Lowe, O. A., Jr., J. E. Sirrine Co., Greenville, S. C.
Minturn, F. H., Lewisburg Light & Power Dept., Lewisburg, Tenn.
Robertson, J. P., Jr., Bessemer Elec. Service, Bessemer, Ala.
Robinson, W. A., J. E. Sirrine Co., Greenville, S. C.
Ross, J. G., Economy Elec. Co., Charlotte, N. C.
Scott, H. L., Southwestern Gas & Elec. Co., Shreveport, La.
Ware, J. H., Jr., Mathieson Chemical Corp., Lake Charles, La.

5. Great Lakes

Ackmann, L. F., Allis-Chalmers Mfg. Co., Chicago, Ill.
Barbaras, R. S., S. & C. Elec. Co., Chicago, Ill.
Barry, J. E., Square D Co., Detroit, Mich.
Behrens, C., Jr., Federal Tel. & Radio Corp., Elkhart, Ind.
Chlumsky, S. J., Commonwealth Edison Co., Chicago, Ill.
Chumbley, C. M., General Elec. Co., Chicago, Ill.
Dres, W. J., G. & W. Elec. Specialties Co., Chicago, Ill.
Ducey, T. R., General Elec. Supply Corp., Chicago, Ill.
Dunsheath, T. J., Magnaflux Corp., Chicago, Ill.
Duras, R. J., General Elec. Co., Ft. Wayne, Ind.
Eddy, L. C. (re-election), Public Service Co. of No. Ill. Chicago, Ill.
Gannon, C. T., P. R. Mallory & Co., Indianapolis, Ind.
Gens, H. J., G.-M. Labs., Chicago, Ill.
Gray, F. J., Electro-Motive Div. of G. M., La Grange, Ill.
Harring, R. J., Automatic Elec. Co., Chicago, Ill.
Harrison, E. H., General Elec. Supply Corp., Chicago, Ill.
Kovac, G. M., Rockford Elec. Eqpt. Co., Rockford, Ill.
Lobdell, W. E., Public Service Co. of No. Illinois, Maywood, Ill.
MacKenna, R. B., Pioneer Service & Engg. Co., Chicago, Ill.
Martin, R. L., Chicago Park District, Chicago, Ill.
McDonald, J. J., Pullman Standard Car Co., Hammond, Ind.
Mistic, G., Underwriters' Labs., Inc., Chicago, Ill.
Moffett, V. L., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Moran, P. H., N. W. Bell Tel. Co., Duluth, Minn.
Mueller, C. T., Chicago Park District, Chicago, Ill.
Otstot, R. E., Jr., Michigan Bell Tel. Co., Saginaw, Mich.
Rafter, C. S., American Tel. & Tel. Co., Chicago, Ill.
Ranney, J. L., Central Illinois Light Co., Peoria, Ill.
Richards, S. A., Electro-Motive Div. G. M., La Grange, Ill.
Russell, D. W., Public Service Co. of No. Illinois, Maywood, Ill.
Schleicher, G. P., Illinois Bell Tel. Co., Chicago, Ill.
Schorsch, V. A., Public Service Co. of No. Ill., Maywood, Ill.
Scott, T. W. A. (re-election), Public Service Co. of No. Illinois, Maywood, Ill.
Shade, C. W., G. & W. Elec. Specialty Co., Chicago, Ill.
Shields, W. H., Commonwealth & Southern Corp. of N. Y., Jackson, Mich.
Silva, A. D., Jr., Columbus Process Co., Columbus, Ind.
Temple, F. D., 226 W. Jackson Blvd., Chicago, Ill.
Thompson, J. R., Carnegie-Illinois Steel Co., Gary, Ind.
Vance, S. M., General Elec. Co., Chicago, Ill.
Vostry, E. J., Electro-Motive Div. G. M., La Grange, Ill.
White, R. F., Allison Div. G. M. C., Indianapolis, Ind.

6. North Central

Beach, R. K., Univ. of Wyoming, Laramie, Wyo.
Flahart, D. O., 607 St. Joe Street, Rapid City, S. Dak.
Knox, J. W., Mountain States Tel. & Tel. Co., Denver, Colo.
Shalla, L. C., Omaha Public Power District, Omaha, Nebr.
Springer, J. J., Public Service Co. of Colo., Denver, Colo.
Waller, M. H., U. S. Bureau of Reclamation, Casper, Wyo.

7. South West

Albert, N. J., Black & Veatch, Kansas City, Mo.
Ault, J. C., Union Elec. Co. of Missouri, St. Louis, Mo.
Berman, G., E., Mexican Light & Power Co., Mexico, Federal District, Mexico
Biggers, B., Southwestern Public Service Co., Plainview, Tex.
Cease, J. E., Public Service Co. of Oklahoma, Tulsa, Okla.
Drake, R. E., Southwestern Public Service Co., Denver City, Tex.
du Rostu, B., Mexican Light & Power Co., Mexico, Federal District, Mexico
Edinborgh, J. A., Univ. of Wichita Research Foundation, Wichita, Kans.
Gomez, G., J. G., General Elec. Co., Mexico, Federal District, Mexico
Grier, L. H., Southwestern Bell Tel. Co., Wichita, Kans.
Groh, H. S., Evans Electrical Construction Co., Kansas City, Mo.
Heidebrecht, A. R., Kansas Gas & Elec. Co., Independence, Kans.
Joerden, R. H., Arkansas Power & Light Co., Pine Bluff, Ark.
James, F. B., Arkansas Power & Light Co., Searcy, Ark.
Kilburn, F. H., Arkansas Valley Elec. Corp., Hutchinson, Kans.
Kincade, O., Foster Wheeler Corp., Houston, Tex.
Koop, A. B., Westinghouse Elec. Corp., Wichita, Kans.
Lane, R. C., Aluminum Co. of America, Kansas City, Mo.
Martin, G. E., Black & Veatch, Kansas City, Mo.
McAnally, J. W., Texas Elec. Service Co., Eastland, Tex.
Nitterauer, F. D., Southwestern Bell Tel. Co., Dallas, Tex.
Rhodes, E. C., Black & Veatch, Kansas City, Mo.
Rumph, L. M., Kansas Gas & Elec. Co., Wichita, Kans.
Smith, J. C., Fargo Eng. Co., Austin, Tex.
Starkey, M. R., Southwestern Bell Tel. Co., Wichita, Kans.
Thomson, W. A., Gulf States Utilities Co., Beaumont, Tex.
Watkins, G. A., Chas. L. Ward Co., Kansas City, Mo.

8. Pacific

Burnet, J. W., Johannessen & Girand., Phoenix, Ariz.
Abel, G. C., California State Polytechnic College, San Luis Obispo, Calif.
Bennett, M. M., Sulphur Spring Valley Elec. Coop., Willcox, Ariz.
Boehle, N. E., So. Calif. Edison Co., Alhambra, Calif.
Carlin, G. H., Central Arizona Light & Power Co., Phoenix, Ariz.
Carter, B. F., Vincon-Carter Elec. Co., Phoenix, Ariz.
Davis, W., Bechtel Corp., Los Angeles, Calif.
Evans, D. B., Westinghouse Corp., Sunnyvale, Calif.
Garber, B., U. S. Bureau of Reclamation, Phoenix, Ariz.
Gohring, J. F., J. E. Redmond Supply Co., Phoenix, Ariz.
Greer, J. O., Calif. Inst. of Technology, Pasadena, Calif.
Higgins, M. W., Central Arizona Light & Power Co., Phoenix, Ariz.
Holland, H. L., Los Angeles Dept. of Water & Power, Los Angeles, Calif.
Johnson, A. B., Westinghouse Elec. Corp., Sacramento, Calif.
Kiger, G. T., City of Phoenix, Phoenix, Ariz.
Landis, R. I., North American Aviation, Downey, Calif.
Lawhead, L. V., Jr., Lockheed Aircraft Corp., Burbank, Calif.
Magee, A. E., 1033 Penn Place, Tucson, Ariz.
Marshall, J. A., General Elec. Co., Los Angeles, Calif.
Mizell, M. H. (re-election), Associated Tel. Co., Santa Monica, Calif.
Robinson, G., Burnie M. Craig, Pasadena, Calif.
Sanborn, R. P., Colorado River Comm., Henderson, Nev.
Schoenduve, H. W., Carl A. Stone Co., Los Angeles, Calif.
Schreiner, R., North American Aviation, Inglewood, Calif.
Schwarzmann, W. A., Phaostron Co., S. Pasadena, Calif.
Simanton, J. R., General Cable Corp., Emeryville, Calif.
Walz, C. W., Jr., C. F. Braun & Co., Alhambra, Calif.

9. North West

Bryner, D. L., Utah Power & Light Co., Salt Lake City, Utah
Clark, R. G., General Elec. Co., Richland, Wash.
Doig, J. A., Portland General Elec., Portland, Oreg.
Durnford, R. F., Montana State College, Bozeman, Mont.
Gant, D. W., Puget Sound Power & Light Co., Seattle, Wash.
Laws, R. N., Chicago, Milwaukee, St. Paul & Pacific R. R. Co., Butte, Mont.
Perry, W. T., Bonneville Power Admin. Portland, Oreg.
Smith, L. J., Western Electrical Construction Co. Portland, Oreg.
Sweeney, R. P., The Pacific Tel. & Tel. Co., Portland, Oreg.
Swezea, G. L., General Elec. Co., Richland, Wash.
Westernfield, G. T., Pacific Tel. & Tel. Co., Portland Oreg.

10. Canada

Bartley, E. J., Robert A. Rankin & Co., Ltd., Montreal, Quebec, Canada
Brown, H. E., Ontario Paper Co., Ltd., Thorold, Ontario, Canada
Chernish, G., Canadian Comstock Co., St. Catharines, Ontario, Canada
Curtis, R. W., Univ. of Manitoba, Winnipeg, Manitoba, Canada
Davis, G. T., Canadian General Elec. Co., Ltd., Peterboro, Ontario, Canada
Gans, N., Bepco Canada Ltd., Montreal, Quebec, Canada
Green, M., North-West Tel. Co., Vancouver, British Columbia, Canada
Kerr, T. A., North American Cyanamid Ltd., Niagara Falls, Ontario, Canada
Knapp, J. W., B. C. Elec. Co., Vancouver, British Columbia, Canada
McKenzie, G. C., Westminster Paper Co., New Westminster, British Columbia, Canada
Nablo, H. W., Hydro Elec. Power Comm. of Ontario, Toronto, Ontario, Canada
Patterson, L. A., Elec. Power & Equipment, Vancouver, British Columbia, Canada
Rickard, H. J. C., B. C. Elec. Railway Co., Vancouver, British Columbia, Canada

Elsewhere

Ashmawy, S. A., Ministry of Public Works, Cairo, Egypt
Bey M., L. H., Paseo Atkinson No. 54, Valparaiso, Chile, South America
Cabo y M., R. E., Compania Azucarera Atlantica del Golfo S. A. Central Lugareno, Prov. de Camaguey-Cuba
Canoun, C. A., Iraq Petroleum Co., Ltd., Tripoli, Lebanon
Douglas, R. N., Electriciteitsbedrijf "Electra" Oranjestad, Aruba, Netherlands West Indies
Ghose, R. N., College of Engg. & Tech. Bengal, India
Godfrey, S. S., South East London Technical College, London, England
Gupta, R. K., Harduaganj Steam Station, Aligarh, United Province, India
Kaneff, S., Univ. of Adelaide, Adelaide, South Australia
Majumdar, S., English Elec. Co., Stafford, England
Misra, C. J.-G., Govt. Steam Power House, Aligarh, United Province, India
Rama, Char, T. L., Indian Institute of Science, Bangalore, India
Ramanathan, A., College of Engg., Guindy, Madras, India
Rao, Narla Tata; Modi, Kamptee, Central Provinces & Berar, India
Sachse, H. B., Siemens & Haiske, Heidenhein, Germany, U.S.-Zone
Sandler, B. T., 128 Pine Road, Mt. Carmel, Haifa, Israel

Total to grade of Associate
United States, Canada, and Mexico, 266
Elsewhere, 16

OF CURRENT INTEREST

Survey Shows Intelligence Rated Top Quality in Engineering Employees

Intelligence is the most highly sought after personal quality in an engineering employee in the opinion of 44 of the nation's top-level engineering executives, who participated in a survey recently concluded by the Engineers' Council for Professional Development to provide facts about human personality which would be valuable in its program of student and professional development. Results of the 3-year survey which was broadened to include opinions of college administrators, faculty, personnel officials, and engineering students, are published in a 25 page-booklet, "The Most Desirable Personal Characteristics," in which the data submitted by 1,033 respondents are plotted in 15 bar charts and curves, and interpreted by the ECPD Subcommittee on Student Development.

DEPENDABILITY RATED SECOND

Asked to list six carefully selected positive characteristics of human personality in the order of the most desirable, 80 per cent of the executives gave first or second place to intelligence, thus rating it first among the desirable characteristics. Physical acceptability, defined as masculinity, good carriage, cleanliness, and so on, was rated as least important, with 93 per cent of the respondents giving this characteristic fifth or sixth place. Dependability was rated second among the most desirable characteristics; organizational acceptability as third; energy as fourth; and emotional acceptability as fifth.

Surprisingly enough, the returns for engineering school administrators, faculty, personnel officials, and even engineering students fell into the same order of importance as that charted by the executive group. In the case of students, a wider scattering of choice was indicated particularly in the end positions, where the more experienced respondents made decisive choices.

INTERPRETATION OF CHARACTERISTICS

Another interesting result of the survey is the light it throws on the interpretation by the respondents of the meaning of the personal characteristics they were asked to rate. Six descriptive subheads were listed under each characteristic to clarify its meaning for those answering the questionnaire. For example, under the main characteristic, "intelligent," the following six subheads were listed: clear thinking; reasonable; careful; imaginative; shrewd; and adaptable. Respondents were asked to list the subheads in order of importance. The returns were revealing.

In general there was good agreement on what the main characteristics meant. For all respondents the intelligent man was, first, one who was clear thinking and, last, one who was shrewd. The dependable person was one who was truthful and not necessarily one who could get things done. Co-operativeness and consideration were rated the most important qualities of the organizationally acceptable man. But when it came to the term, dynamic, divergence of choices indicated that no one was sure just what the term really meant.

ASPECT OF GROUP OPINION

The survey bears out the hypothesis advanced by the ECPD Subcommittee on Student Development that while human personality could not be defined easily, most people had a good idea of what were the most desirable of the personal characteristics, and that, in fact, these ideas or intuitions about human personality had assumed the aspect of group opinion.

Early in 1946, Donald B. Prentice, at that time chairman of the ECPD Committee on Engineering Schools, expressed the hope of defining these desirable characteristics which industry seeks and the world needs, as an aid to students and young graduate engineers on the way to professional attainment. A Subcommittee on Student Development subsequently was formed under the chairmanship of A. R. Cullimore, then president of Newark College of Engineering, to undertake a personality survey.

A questionnaire was prepared on the basis of six carefully selected personality characteristics, and a pilot group of engineering executives of considerable responsibility and diverse managerial functions residing in widespread geographical areas was enlisted to co-operate in the survey. All members of the pilot group were executives with experience in hiring and direction of young engineers and were known personally to at least one member of the committee.

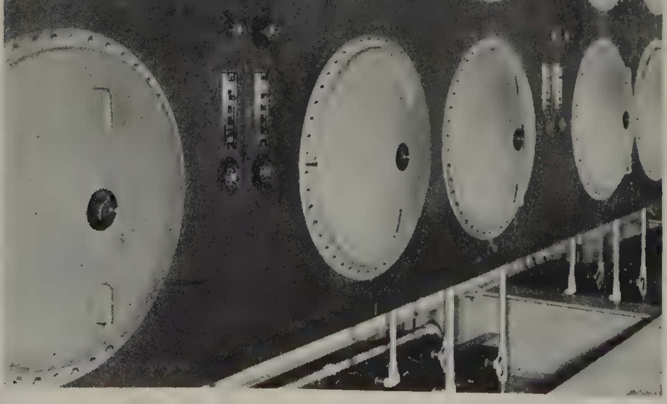
The questionnaire consisted of three parts. The first listed the main characteristics each with six descriptive subheads which respondents were asked to rate in order of importance. The second part consisted of a Form 1, in which the main characteristics were to be listed in the order of the most desirable for men in the general engineering field. Part three was an optional Form 2 divided into the four functional engineering groups as follows: research and invention; design and construction; production and management; and sales and distribution. Form 2 was to be used by those respondents who felt that the order of characteristics as listed for general engineering work was not valid for the functional subdivisions of engineering.

Twenty-eight of the pilot group filled out Form 2, thereby providing significant data pointing up similarities and contrasts among the characteristics most valued by the functional group.

DIFFERENCES OF FUNCTIONAL GROUPS

The desirable characteristics of the research and design groups fell in the same general pattern with the end positions filled by intelligence and physical acceptability, with a good concentration of choice in rating four of the six characteristics. A change, however, was noted in the production and

Ozone Purifies Philadelphia Water



World's largest Ozonator water-treatment generator unit has been installed at the Belmont filtration station, Philadelphia, Pa., by the Welsbach Corporation. The portholes cover glass electrodes, whose sparking creates ozone. This gas removes taste and odor from ordinary water. The Belmont plant eventually will treat 70,000,000 gallons, the power utilization to average 200 kilowatt-hours per million gallons

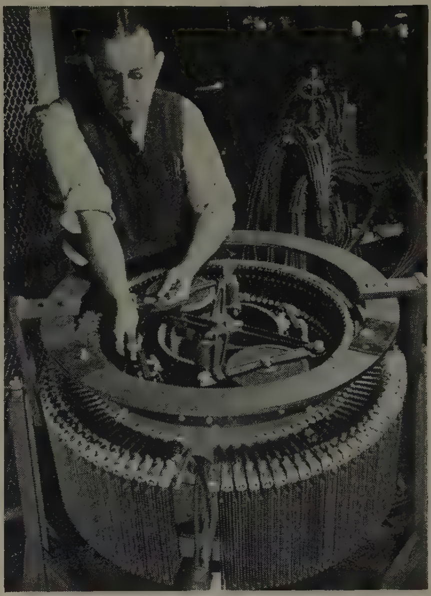
management group. Here intelligence still had first place but held its lead by only a narrow margin with most of the other characteristics having higher ratings.

A radical departure from the usual arrangement of characteristics was noted in the sales and distribution group. Here "dynamic" rather than "intelligent" was the paramount quality with "physical" acceptability, which consistently rated sixth, running a close second. The returns showed no concentration of choices which was interpreted to mean there is no general type of sales personality.

While the committee believes that the survey was an important contribution to the field of personality study, it cautions against conceiving the project beyond what it was intended to be—"a rough measurement in a rugged terrain."

Copies of the report may be obtained from ECPD, 29 West 39th Street, New York 18, N. Y. Price per copy is 25 cents.

Trolley Car Starter Has 99 Steps



This barrel-like electric accelerator promises greater passenger comfort by eliminating jerky stops and starts in trolley cars. During acceleration, the X-shaped arm revolves, the two wheels press down on the 99 electrical contacts in rapid succession, and the power is fed to the driving motors in a gradually increasing surge. In stopping, the process is reversed

American Inventors Association to Hold Exposition in New York

The first International Inventors Exposition, sponsored by the American Inventors Association (AIA), a nonprofit organization, will be held in Grand Central Palace, New York, N. Y., June 4–11, 1949.

The prime purpose of the sponsors is to provide an opportunity for corporations and for individual inventors, particularly, to sample public opinion and, at the same time, show their products to industrial leaders. The show committee will screen all applications carefully. Only products with unusual merit and promise will be put on exhibit.

As G. A. Parsons, managing director of the exposition states, "Special consideration will be given to inventions that create new jobs. Inventions generally create more employment than they take away; as evidence of this, the plastics industry has created new jobs supplying products to every phase of our existence."

One of the main purposes of this exposition is to encourage inventors. To that end, the show committee will have available a guidance council of accredited scientists who will give free advice to embryo inventors.

The facilities of the exhibition hall will be allocated to approved applicants who will be furnished private booths for their inventions at an absolute minimum of cost ($50 regardless of extent of space required, plus membership in AIA). Corporations exhibiting new products will be charged the usual rates.

The exhibits will be departmentalized, to assist persons in locating their special interests with a minimum of effort. This show will provide a maximum in human interest. It is interesting to note that in the United States alone more than 35,000 inventions are patented yearly, the total in the world being around 47,000.

The AIA has selected the United Expositions Corporation, 525 Lexington Avenue, New York, N. Y., to handle all show details for them. The officers of AIA are: president, T. G. Jungersen, inventor of the precision casting process which War Production Board officials called one of the most important wartime production methods; first vice-president, Doctor L. L. Wyman of General Electric Company and atomic research fame; second vice-president, Doctor F. A. Hessel, secretary of the Chemists Club; and secretary, Serge Traye, inventor of the Carlat helicopter.

Con Edison Man Lectures British IEE. Ward F. Morehouse (A '14, F '26), of the Consolidated Edison Company of New York, Inc., New York, N. Y., delivered the Supply Section Annual Lecture in London, England, on May 11, 1949. Speaking under the auspices of the Institution of Electrical Engineers, his topic was "Plant Co-ordination—an Example of Co-operation." He discussed procedures that have been developed in the United States for solving the problems of physical and inductive co-ordination of power and communications systems, and presented solutions that have been found to particular problems. The Supply Section Annual Lecture traditionally is given by an engineer from outside of Great Britain. P. M. J. Ailleret of France gave the first lecture in 1937. Mr. Morehouse is the first American speaker in the series.

Jewett Fellowships Awarded for 1949–50. Six promising young scientists were named recently by the American Telephone and Telegraph Company to receive the 1949–50 Frank B. Jewett Fellowships. The awards grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research. The winners of this year's awards are: Doctor Harish-Chandra of the Institute for Advanced Study, Princeton, N. J., and Allahabad, United Provinces, India; Doctor J. A. Jenkins of Harvard University, Cambridge, Mass., and Toronto, Ontario, Canada; Doctor Robert Karplus of the Institute for Advanced Study, Princeton, N. J., and West Newton, Mass.; Doctor Joaquin Mazdak Luttinger of Physikalisches Institut, Zurich, Switzerland and New York, N. Y.; Doctor David Emerson Mann of the University of Minnesota and Minneapolis, Minn.; and Harvey Winston of Columbia University and New York. Two of the winners are physicists, two are mathematicians, and two are chemists. The fellowships are awarded on recommendation of a committee consisting of seven members of the technical staff of Bell Telephone Laboratories, New York, N. Y. Primary criteria are the demonstrated research ability of the applicant, the fundamental importance of the problem he proposes to attack, and the likelihood of his growth as a scientist. The awards are designedly post-doctorate, and only scientists who recently have received doctors' degrees or who are about to receive them normally are considered.

ASEE Meets at Rensselaer. The theme of partnership with industry will keynote the 1949 convention of the American Society for Engineering Education (ASEE) to be held June 20–24, 1949, at Rensselaer Polytechnic Institute, Troy, N. Y., C. J. Freund, dean of engineering at the University of Detroit (Mich.) and national president of the ASEE, announced recently. Twenty-five hundred presidents, deans, and professors of leading engineering colleges, scientists, and industrial leaders will attend the conference. The meeting will coincide with Rensselaer's 125th anniversary celebration. Presentation of the ASEE Lamme Medal and the Westinghouse Award to the recipients for meritorious achievement in the teaching profession will highlight the 5-day sessions. Delegates also will take side trips to industrial plants in the Troy-Albany-Schenectady area. An international conference on engineering education will feature engineering educators from all over the world. There will be programs on instrumentation for engineering research, education in the field of atomic energy, secondary-school developments, and selective-service problems. Approximately 150 papers will be presented by leaders in the educational field dealing with various aspects of engineering education.

Conference on Ionospheric Research. A 3-day conference and symposium will be held at the Pennsylvania State College, June 27–29, to acquaint scientists in the field with the latest theoretical and experimental developments in ionospheric research. Eight to 12 papers following the theme—"Present-Day Research on Radio Wave Propagation via the Ionosphere"—will be presented during the 3-day session. Discussion-conference sessions will be planned after each series of papers to allow free intermingling of the latest ideas and thoughts among the participants. It is expected that an internationally known expert in the field will address the dinner meeting. This conference is being sponsored jointly by the Pennsylvania State College and the Geophysical Research Directorate of the United States Air Forces. Further details may be secured from Doctor A. H. Waynick, the Radio Propagation Laboratories, the Pennsylvania State College, State College, Pa.

H. S. Mudd Awarded Egleston Medal. The Egleston Medal, awarded annually by the Columbia University engineering school Alumni Association for distinguished engineering achievement, will be presented this year to H. S. Mudd, president and managing director of Cyprus Mines Corporation. Mudd's principal professional activity for many years has been the development and management of copper mines in the Island of Cyprus, in the Mediterranean. Currently, he is also director of Texas Gulf Sulphur Company, Mesabe Iron Ore Company, Southern Pacific Company, and Pilgrim Exploration Company. In addition, he is president of Cactus Mines Company and Pacific Alkali Company, as well as voting trustee of Pacific Mutual Life Insurance Company. During the many years of his connection with Cyprus Mines, Mudd has solved numerous complex mining and metallurgical problems involving mine ventilation and safety, fire hazards, and production. In 1929, he helped to establish the Seeley W. Mudd Memorial Fund for the American Institute of Mining and Metallurgical Engineers. The income from the fund is used by the institute to finance researches, publications, and other projects concerned with advancing the sciences and arts of mining and metallurgy. Mudd holds an honorary doctor of science degree from Columbia. He was graduated from the school of mines (now school of engineering) in 1912.

Kerr Made Officer in Companies' Organization. Stewart Kerr, a Detroit, Mich., attorney, has been appointed executive secretary of the National Association of Engineering Companies, W. W. Schmitt, president of the nonprofit organization, announced recently. Kerr served as special assistant to the United States Attorney General in the Department of Justice's Anti-Trust and Criminal Divisions. The new executive secretary's broad experience in government contracts and familiarity with engineering companies and their practices led to his appointment. The program of the National Association of Engineering Companies, which is now in the process of formulation, will be made public at a future date.

Atchison Heads NBS Guided Missile Work. F. S. Atchison has been appointed chief of the missile intelligence section of the National Bureau of Standards, where he will deal with intelligence systems for guided missiles. Doctor Atchison has worked in nuclear physics (in connection with studies of angular distributions and cross sections of light-element nuclear reactions at the State University of Iowa, Iowa City); in the design of radio proximity fuses for bombs, rockets, and mortars; and in the design of electronic systems for guided missile control at the National Bureau of Standards. In connection with the proximity fuse work, he was the technical advisor to the Air Force in the Pacific Theater during their first use of proximity fuse bombs at the invasion of Iwo Jima. Atchison joined the staff of the National Bureau of Standards in 1942, working in the ordnance development division. From 1938 to 1942 he was a research assistant at the State University of Iowa, and from 1937 to 1938 a high school instructor in science and mathematics at Cairo, Illinois. A 1938 graduate of South East Missouri State College, he later attended the State University of Iowa from 1938 to 1942, receiving his master's and doctor's degrees in 1940 and 1942, respectively. He is a member of the American Physical Society and Sigma Xi.

Technical Sessions Follow NOL Dedication. The Naval Ordnance Laboratory aerobalistics facilities at White Oak, Md., will be dedicated formally on June 27, 1949. These facilities include supersonic and hypersonic wind tunnels and transonic and pressurized ballistics ranges. The formal dedication will be followed, June 27–29, by five half-day technical sessions on general aerodynamics, ordnance aeroballistics (restricted), theoretical supersonic and transonic aerodynamics, and experimental supersonic aerodynamics. Outstanding American and foreign scientists have been invited to present papers at these technical sessions. In connection with the dedication and technical sessions, the fluid dynamics division of the American Physical Society will meet at the Naval Ordnance Laboratory on June 30 and July 1. There will be symposia on turbulence, shock-wave phenomena, and aerothermodynamics, in addition to contributed papers. Persons interested in attending the dedication and technical sessions of June 27–29 should address request for invitations to Doctor R. J. Seeger of the Naval Ordnance Laboratory.

FM Clinic Held in NYC. A frequency modulation clinic sponsored by the FM Association was held at the Hotel Commodore in New York, N. Y., on April 1, 1949. Subject of this first sales clinic was "What's Wrong in FM?" and was directed to frequency modulation broadcasters as well as to advertising time buyers and manufacturers. At a luncheon session Major E. H. Armstrong, frequency modulation pioneer, spoke briefly on the history of frequency modulation. A demonstration of the staticfree reception inherent in frequency modulation receivers was demonstrated graphically by means of a series of magnetic tape recordings of broadcasts picked up on frequency modulation and amplitude receivers under very poor reception conditions. Edgar Kobak, president of Mutual Broadcasting System, addressed the luncheon gathering, pointing out that too many people in radio and advertising do not realize the advantages of frequency modulation from the point of good coverage and good reception under all conditions. During the sessions, case histories of good and bad frequency modulation sales promotion by broadcasters and manufacturers were cited.

Newlon Named to NBS. A. E. Newlon, formerly with Stromberg-Carlson Company, has been appointed to the staff of the National Bureau of Standards, where he will work in the Ordnance Research Laboratory of the bureau's Electronics Division. Newlon has done extensive research on broadcast and frequency-modulation receivers, television receivers and test equipment, and radar. From 1941 to 1948, he was senior radio engineer with Stromberg-Carlson. At the time he left, he was in charge of all broadcast-receiver research, including circuits and manufacturing techniques. During this time, Newlon also acted as representative of Stromberg-Carlson on 13 Radio Manufacturers Association committees concerned with television and frequency modulation. Engaged in research and development for RCA license division laboratory 1936–41, he previously worked for the Muzak Corporation of Ohio and the United States Coast and Geodetic Survey in Washington. A 1933 graduate of Ohio State University, Newlon has been elected to membership in Phi Eta Sigma, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. He is a member of the Institute of Radio Engineers.

Norcross, AIP Official, Dies. Cleveland Norcross, general manager of the American Institute of Physics, New York, N. Y., died March 21, 1949, at the age of 37. Prior to joining the institute staff, July 1, 1947, Norcross was executive secretary of the Office of Scientific Research and Development (OSRD), and during the war he administered the expenditure of a half billion dollars in research contracts. For his services to the OSRD he was awarded the Certificate of Merit at the direction of the President of the United States. Born in Denver, Colo., Norcross was a graduate of the Wharton School of Finance and Commerce, University of Pennsylvania. After three years at R. H. Macy and Company, New York, N. Y., he joined the personnel department of the Home Owners Loan Corporation in Washington, D. C., and in 1940 he became associated with the government's war research program.

Electronic Digital Computer Course. A 48-lecture course on the design of electronic digital computing machines is now available to the American public, the Office of Tech-

Future Meetings of Other Societies

American Electroplaters' Society. Annual convention. June 27–30, 1949, Hotel Schroeder, Milwaukee, Wis.

American Gear Manufacturers Association. Annual meeting. June 6–8, 1949, The Homestead, Hot Springs, Va.

American Society of Mechanical Engineers. Semiannual meeting. June 27–30, 1949, San Francisco, Calif.

Engineering Foundation. June 16, 1949, Engineering Societies Building, New York, N. Y.

Illuminating Engineering Society. National Technical Conference. August 21–25, 1949, Los Angeles, Calif.

National Bureau of Standards. Two symposia on numerical analysis. Symposium I, June 24–25, 1949; Symposium II, June 27–29, 1949; (dates are tentative), Institute for Numerical Analysis, Los Angeles, Calif.

Practising Law Institute. Conference on Current Problems in Patent Law. Annual summer session. July 18–22, 1949, Hotel Statler, New York, N. Y.

Society of Automotive Engineers. Summer meeting. June 5–10, 1949, French Lick Springs, French Lick, Ind.

nical Services of the Department of Commerce announced recently. Sponsored by the Army and Navy, the course first was given in 1946 by 19 leaders in mathematics and electronics at the Moore school of the University of Pennsylvania, home of the ENIAC and EDVAC computers. The lectures since have been largely revised, and collected for the use of other workers interested in the field. Both practical and theoretical aspects of computing machines are discussed, and historical material is given tracing computing devices from the abacus to the mechanical, the electric-relay, and finally the electronic computer. Limited supplies of the lecture series, in four volumes, may be purchased from the Moore School, University of Pennsylvania, Philadelphia 4, Pa., at $5 per volume. When this supply is exhausted, microfilm and photostat copies may be secured from the Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C. Also available from the Library of Congress is, PB 96703, "Preliminary Discussion of the Logical Design of an Electronic Computing Instrument," prepared by the Institute for Advanced Study at Princeton, N. J. This 57-page report is available at $2.75 in microfilm, $7.50 in photostat.

McGraw-Hill Nuclear Series. Prepared as a record of the research carried on under the Manhattan Project and later under the Atomic Energy Commission, the "National Nuclear Energy Series (Manhattan Project Technical Section)" is being edited by a trained staff of specialists at Oak Ridge. The series will be published by McGraw-Hill under a subcontract with Columbia University. The volumes, which will be released as they are declassified, are grouped into eight divisions: (1) Electromagnetic Separation Project; (2) Gaseous Diffusion Project; (3) Special Separations Project; (4) Plutonium Project; (5) Los Alamos Project; (6) University of Rochester Project; (7) Material Procurement Project; and (8) Manhattan Project.

Magnetic Sound on Film Equipment to Be Produced. Eastman Kodak Company of Rochester, N. Y., has been licensed by Armour Research Foundation of Illinois Institute of Technology to manufacture and sell motion-picture film with a magnetic sound track. Kodak will sell film already coated with a magnetic sound track and will add a track to exposed film for both professional and amateur use. Some 55 other licensees are manufacturing and selling magnetic recording equipment based upon Research Foundation patents. Three companies, Ampro Corporation, Bell and Howell Company, and Revere Camera Company, all foundation licensees, are planning to manufacture motion picture projectors which incorporate magnetic sound. The modern magnetic recorder was developed in the Armour Research Foundation laboratories by Marvin Camras, Illinois Institute of Technology graduate and now research physicist at the foundation.

Lack Heads Communications Association. Election of Fred R. Lack of New York, N. Y., vice-president of Western Electric Company, as president of the Armed Forces Communications Association was announced recently. Lack, a member of the Industry Advisory Committee for the Armed Services during and since World War II, succeeds, as president, Brigadier General David Sarnoff, chairman of the board of the Radio Corporation of America, who has served as president of the association since its formation in 1946. Vice-presidents elected are T. S. Gary, of Chicago, Ill., vice-president of Automatic Electric Company; T. J. Hargrave, of New York, N. Y., president of the Eastman Kodak Company; Rear Admiral E. E. Stone, of Washington, D. C., Chief of Naval Communications; J. R. Cunningham, of United Air Lines at Denver, Colo.; and C. O. Bickelhaupt, of New York, N. Y., vice-president of American Telephone and Telegraph Company. New directors of the association are Walter Evans, of Baltimore, Md., vice-president of Westinghouse Electric Corporation; Paul Goldsborough, of Kansas City, Mo., with Trans World Airlines; and W. G. Eaton, of Dayton, Ohio, civilian scientist at the Wright Field Electronics Laboratory.

General Electric Fellowships Awarded. Research fellowships amounting to $18,460 have been awarded by the General Electric Company under its education fund to 15 graduate students for advanced study. Seven of the students received Charles A. Coffin Fellowships for advanced study in electricity, physics, and the physical sciences. Eight other students were awarded Gerard Swope Fellowships for advanced study in industrial management, engineering, the physical sciences, and various scientific and industrial fields. The fellowships are awarded annually on a competitive basis to graduates of universities, colleges, and technical schools who have shown through previous work that they could undertake or continue advanced study either in the United States or abroad. Winners of the awards may receive up to $1,500, plus a grant for any special equipment needed in their chosen field of research. Loans also may be available to the students during their period of study. Funds for both the Coffin and Swope fellowships come from the income derived from the $1,000,000 General Electric education fund.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Illumination Terms

To the Editor:

I wish to object to the incorrect use of illumination terms in the article by Peter C. Goldmark on "Brightness and Contrast in Television" (*EE, Mar '49, pp 237–42*). On page 237 we find the rather astounding statement ". . . the illumination of the area surrounding the receiver is more than 20 foot-lamberts." This error is repeated in subsequent paragraphs. The unit of illumination is foot-candles and refers to light flux per square foot falling normal to the surface. Foot-lamberts is a unit of brightness and refers to light flux (lumens per square foot) leaving the surface.

On page 170 of the 1942 edition of "American Standard Definitions of Electrical Terms," the foot-lambert is defined as the average "brightness of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot." A more exact definition is

$$B' = \pi \frac{dI}{dA \cos\theta}$$

where B' is in foot-lamberts, I is in candlepower, $dA \cos\theta$ is the projected area of the emitting surface as viewed by the observer.

The foregoing definition is independent of the type of surface involved, although hard to apply in practice. Thus, while both foot-candles and foot-lamberts have the same dimensions, that is, "lumens per square foot," physically they are quite different.

The confusion in terminology illustrated by this article is very common. Paradoxically enough, the pressure of recent developments in electronics and television has pushed the subject of illumination out of the curriculum for communication majors. If errors of nomenclature continue to be made even by acknowledged leaders in the television field, then no doubt this course or its subject matter will have to be reinstated in order to keep the embryo engineer straight.

It is regrettable that an article which gives the theoretical justification for filters in television receivers should be spoiled by the errors of terminology. I hope that television manufacturers will see their way clear to make such filters an integral part of commercial receivers.

ABRAHAM ABRAMOWITZ (M '47)

(Assistant professor of electrical engineering, The City College of New York, New York, N. Y.)

Measuring Heavy Direct Currents

To the Editor:

It was of great interest to see the item, "Measuring Heavy Direct Currents" (*EE, Mar '49, p 242*), and it may be of historical interest that such d-c transformers were developed by W. Kramer and built more than ten years ago in the transformer works of the AEG, Berlin, Germany. Kramer published some papers which have become well known in connection with the theory of magnetic amplifiers in general. They are listed in the following:

1. A New D-C Current Transformer With Real Current Transformer Characteristics, **W. Kramer.** *Elektrotechnische Zeitschrift* (Berlin, Germany), volume 58, 1937, page 1309.

2. A New D-C Potential Transformer for the Measurement of High D-C Voltages, **W. Kramer.** *Elektrotechnische Zeitschrift* (Berlin, Germany), volume 59, 1938, page 1295.

3. Bibliography on Transductors, Magnetic Amplifiers, Etc., **H. B. Rex.** *Instruments* (Pittsburgh, Pa.), volume 21, 1948, page 332.

ERIC T. B. GROSS (F '48)

(Department of Electrical Engineering Illinois Institute of Technology, Chicago, Ill.)

MECHANICAL TESTING OF METALS AND ALLOYS. By P. F. Foster. Fourth edition. Sir Isaac Pitman and Sons, Ltd., London, England, 1948. 319 pages, illustrations, diagrams, charts, tables, $8^{3}/_{4}$ by $5^{1}/_{2}$ inches, cloth, 18s. Modern testing equipment and methods are described in detail following a discussion of the elementary theory of elasticity and the structure of metals. The book also includes the fundamentals of present-day developments in metals testing, certain test phenomena and the meaning of the characteristic results, and a group of tables of properties of metals and alloys.

MECHANICS. (Pennsylvania State College Industrial Series.) By J. W. Breneman. Second edition. McGraw-Hill Book Company, New York, N. Y.; Toronto, Ontario, Canada; London, England, 1948. 144 pages. diagrams, tables, $9^{1}/_{4}$ by 6 inches, cloth, $2.50. A simplified presentation of the fundamentals of mechanics, this volume is intended for students with a limited mathematical background. Stress is laid on the application of principles to important practical problems common to industry. In addition to conventional topics, there is a complete study of levers, pulleys, gears and gear trains, and mechanisms. In this new edition, the material has undergone considerable revision, and a large number of problems has been added.

NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ALTERNATING-CURRENT MOTORS. By L. R. Drinkall. F. Hodik, and E. T. Groat. American Technical Society, Chicago 37, Ill., 1948. 367 pages, illustrations, diagrams, charts, tables, $8^{1}/_{2}$ by $5^{1}/_{2}$ inches, linen, $3. For both the beginner and experienced worker, this book provides a background of information on the operation, construction, and maintenance of a-c motors. In addition to single and 3-phase motors, a-c generators also are discussed. The selection of motors for particular uses is considered.

BUSINESS, LEGAL, AND ETHICAL PHASES OF ENGINEERING. By D. T. Canfield and J. H. Bowman. McGraw-Hill Book Company, New York, N. Y.; Toronto, Ontario, Canada; London, England, 1948. 358 pages, diagrams, charts, tables, $9^{1}/_{4}$ by 6 inches, cloth, $4.50. A revision and a combination of "Business Administration for Engineers" and "Legal and Ethical Phases of Engineering." It provides engineering students with detailed discussions of various situations within these fields which they are likely to encounter in practice, and is general enough for any type of engineer.

COMPANY WAGE POLICIES. (Industrial Relations Section Research Report Series: Number 77). By R. A. Lester. Princeton University, Princeton, N. J., 1948. 45 pages, $9^{1}/_{4}$ by 6 inches, paper, $1.50. This brief study is the result of a survey of the processes by which wage policy is determined by some 100 representative manufacturing companies in the United States, small and large. Topics dealt with include the basis for plant level of rates, factors in wage-level charges, and the consequences of intercompany uniformity.

DEVELOPMENT OF THEORETICAL ELECTROCHEMISTRY (22d Annual Priestley Lectures). By R. M. Fuoss, sponsored by Phi Lambda Upsilon and the department of chemistry, Pennsylvania State College, State College, Pa., 1948. 24 pages, 11 by $8^{1}/_{2}$ inches, paper, $2. This historical survey of theoretical electrochemistry focuses attention on some of the outstanding developments and shows how modern chemical theory was influenced by these researches. It is divided into five chapters: discussion of the work of Henry and Volta; description of the first recorded experiments on electrolysis; consideration of Ohm, Wheatstone, Poggendorf, Hittorf, and Kohlrausch; the dissociation theory of Arrhenius; work done in the 20th century.

ENGINEERING DRAWING PROBLEMS, to accompany French's Engineering Drawing, Series I. Prepared by C. D. Cooper, P. E. Machovina, and C. J. Vierck. McGraw-Hill Book Company, New York, N. Y.; Toronto, Ontario, Canada; London, England, 1948. No pagination, diagrams, charts, 11 by 18 inches, paper, $3.50. In this set of prepared sheets and layouts are presented problems designed to cover the fundamental subjects ordinarily taught in an elementary course. The working-drawing problem is presented as a design drawing from which the student, working as a detailer, makes a complete set. Since the use of instruments is developed along with the other topics the first orthographic problems provide useful freehand practice.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

ENGINEERING MACHINE SHOP PRACTICE. By B. R. Hilton. Second edition. Sir Isaac Pitman and Sons, Ltd., London, England, 1946. 189 pages, illustrations, diagrams, charts, tables, $7^{1}/_{2}$ by 5 inches, fabrikoid, 6s. This book, written for students and apprentices of production engineering, covers fundamental principles and forms a useful aid to practical work as well as a guide to the technology of the subject. Suggestions are included on technique, on the correct choice and use of hand and machine tools, and on pitfalls to avoid.

LATEST DEVELOPMENTS OF DAMS AND HYDROELECTRIC POWER STATIONS IN FRANCE. By A. Coyne. Société des Ingenieurs Civils de France, British Section, 82 Victoria Street, London, S.W.1, England, 1947. 27 pages, illustrations, diagrams, $9^{1}/_{2}$ by $7^{1}/_{2}$ inches, paper, 5s. In this pamphlet modern developments in large power station dams are exemplified in considerable detail by certain French installations with particular reference to flood overfalls of the "ski-jump" type. The technical discussion of the paper is included.

MANAGERIAL CONTROL OF BUSINESS. Edited by G. T. Trundle, Jr., and others. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1948. 408 pages, diagrams, charts, tables, $9^{1}/_{4}$ by $5^{3}/_{4}$ inches, linen, $5. Containing material on every phase of business management, this book stresses the principles and methods actually applied to business and industry today. It includes an over-all picture an analysis of company operations as they are practised by leading corporations, a review of general management problems, discussions of the particular aspects of sales management, manufacturing, and industrial relations.

PAMPHLETS • • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

ASTM Booklets. "Symposium on Usefulness and Limitations of Samples," sponsored by the ASTM committee on quality control of materials, and containing technical papers and discussions covering sampling and testing techniques. 40 pages; $1.00 a copy. "ASTM Standards on Paper and Paper Products," containing 77 specifications and test methods for paper and paper products. 286 pages; $2.50 a copy. Both obtainable from the American Society for Testing Materials Headquarters, 1916 Race Street, Philadelphia, Pa.

NBS Technical Bulletins. "Microbiological Deterioration of Organic Materials," Miscellaneous Publication 188, concerned with the prevention of deterioration of textiles, leather, and other organic materials from rot and mildew; price 25 cents. "New Advances in Printed Circuits," Miscellaneous Publication 192, concerned with the latest developments in printed circuits as given in 22 technical papers; 43 illustrations, tables, 73 pages; priced at 40 cents a copy. "Spectral-Transmissive Properties and Use of Eye-Protective Glasses" NBS Circular C471, giving information on the transmissive properties of widely distributed tinted lenses; 93 figures, 34 pages; cost 20 cents per copy. All three obtainable from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C.

Bibliography on Prestressed Reinforced Concrete. A list of 190 references. $4 a copy from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Handbook of Radioactivity and Tracer Methodology, PB93615. Reference book on tracer techniques, fundamental concepts of nuclear physics, isotope production, and instrumentation. 900 pages, $20 per copy. Office of Technical Services, Department of Commerce, Washington 25, D. C.

ELECTRICAL ENGINEERING

Registered United States Patent Office

JUNE
1949

The Cover: Looking through Bexley Hall gateway to Rogers Building, the School of Architecture and Planning, of the Massachusetts Institute of Technology, Cambridge, Mass., which will be inspected during the 1949 AIEE Summer General Meeting in nearby Swampscott.

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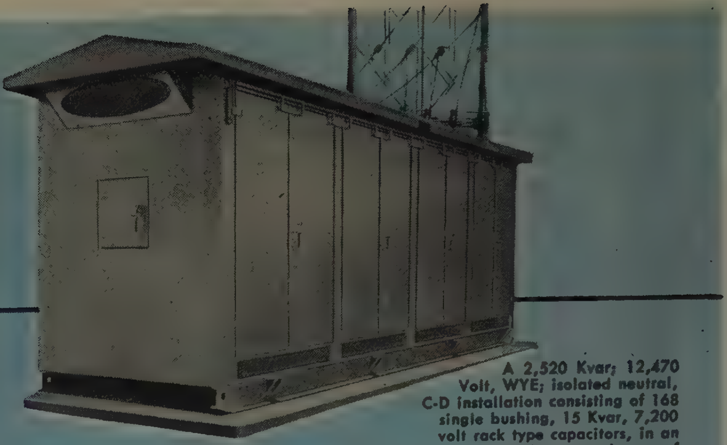
SPECIALIZATION

PAYS DIVIDENDS . . .

when

utilities

install



A 2,520 Kvar; 12,470 Volt, WYE; isolated neutral, C-D installation consisting of 168 single bushing, 15 Kvar, 7,200 volt rack type capacitors, in an outdoor, weather-proof housing, with temperature-controlled, forced ventilation.

CORNELL-DUBILIER CAPACITORS

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That C-D specialization pays dividends is proved by the more than a decade of trouble-free field service delivered by C-D capacitors. It's the kind of equipment you can install and forget, proving once again that *the specialist does it best.* Next time specify C-D—the better capacitor. A C-D field engineer will be glad to discuss with you capacitors designed for your specific power-factor improvement needs. Your inquiry is cordially invited. Catalog on request. Cornell-Dubilier Electric Corporation, Dept. B69, South Plainfield, New Jersey. Other plants in New Bedford, Worcester, Brookline, Mass.; Providence, R. I.; Indianapolis, Ind. and Cleveland, Ohio.

Follow the leaders
Demand dependable C-D Capacitors—built by capacitor specialists.

C-D Best by Field Test!

CORNELL-DUBILIER CAPACITORS
1910 1949
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WORLD'S LARGEST MANUFACTURER OF CAPACITORS

WHEN YOU'RE FIGURING CABLE COSTS* USE THESE FACTS ON FILE ABOUT OKONITE

4700 feet of
Okonite Underground Cable
in service since 1908.....
Removed and Re-Used in 1948

2000 feet of Okovar
Varnished Cambric Cable
Installed Overhead and
put in service in 1927.....
Removed and Re-Used in 1948.

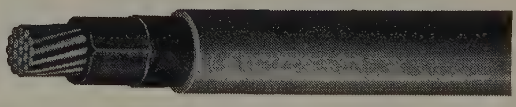
In the files of The Okonite Company are a number of case histories that tell their own story of the long life—the real yardstick of cable economy—that you can count on with Okonite. The two instances cited above are from the records of a single customer.

They are two of eleven instances of cables long used and transferred to new locations by this customer, who has re-installed more than 24 miles of such Okonite cable.

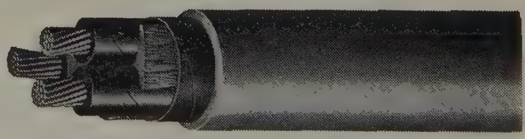
Building true value into cable has been Okonite's business since 1878. What goes into an Okonite cable to make it do a better job...what tests it must pass...what care is taken to control its electrical characteristics—all this and other data are found in Research Bulletin EG-101. For a copy, address The Okonite Company, Passaic, New Jersey.

***with today's installation costs only the *Longest-Lived* will be economical . . . .**

The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.



Okonite rubber insulated lead-covered underground cable.



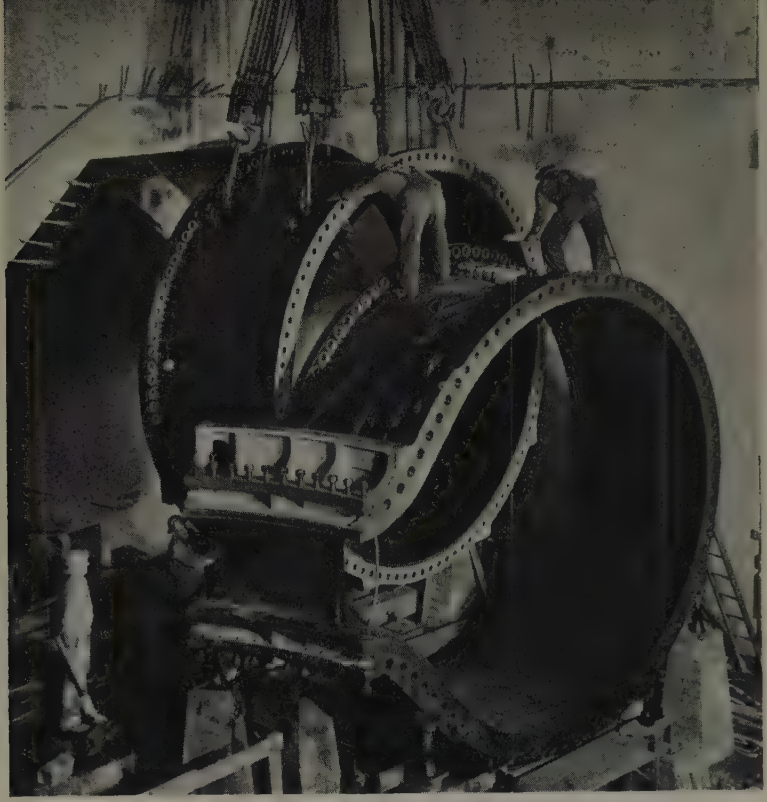
Okovar varnished cambric lead-covered aërial power cable.

THE BEST CABLE IS YOUR BEST POLICY

OKONITE PASSAIC, N.J.

OKONITE OKONITE SINCE 1878 insulated wires and cables

7421

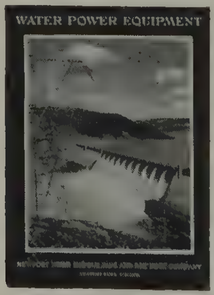


RECORD OUTPUT
FOR GRAND COULEE USING NEWPORT NEWS TURBINES

During 1948 the nine generating units in the west power house at Grand Coulee in the state of Washington produced 8,415,000,000 kwh.

Each generator was driven by a 150,000 horsepower hydraulic turbine built by Newport News.

Nine similar turbines, but of 165,000 horsepower capacity are now being built for the east power house.

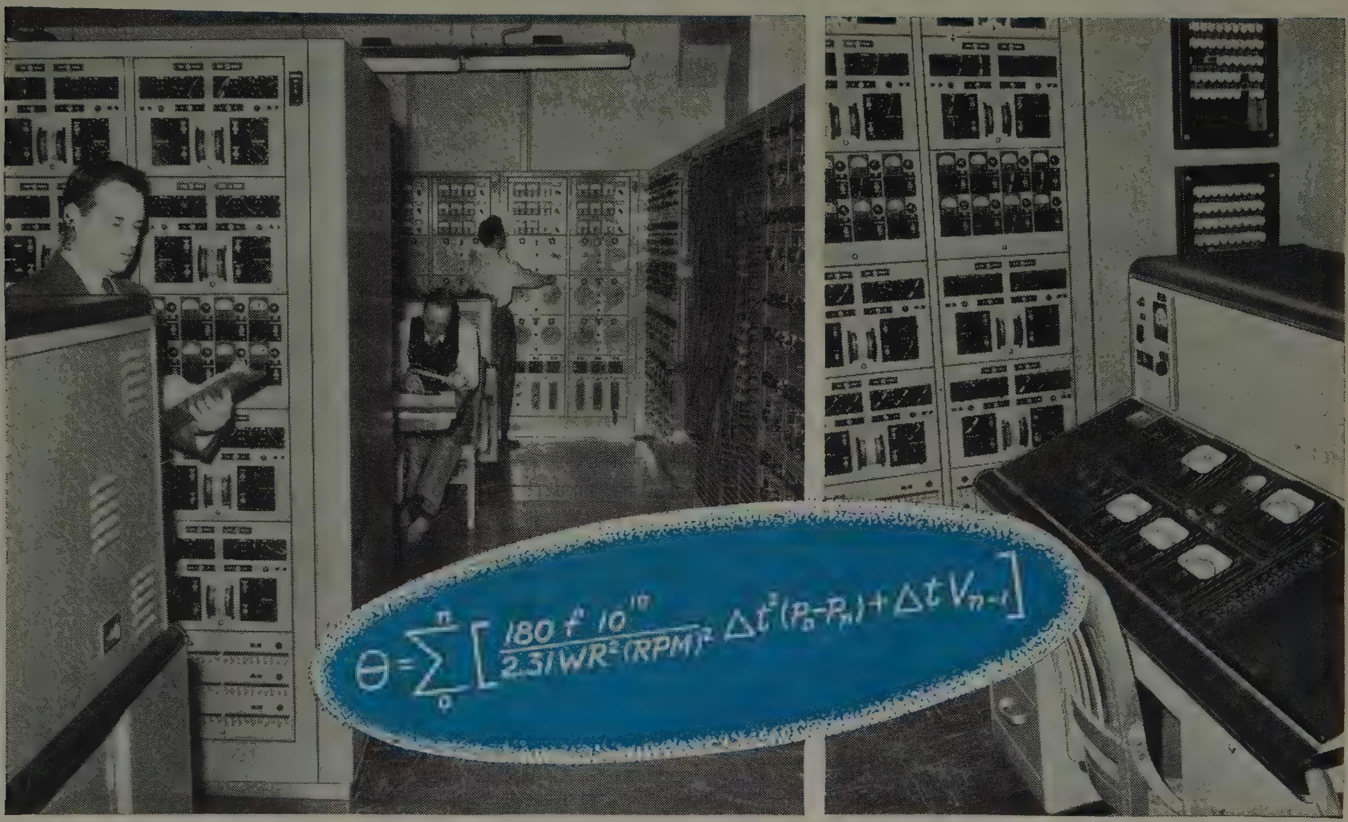


WATER POWER EQUIPMENT

WRITE FOR BOOKLET
ON WATER POWER
EQUIPMENT

NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

YOU CAN BE **SURE**.. IF IT'S
Westinghouse



$$\Theta=\sum_{0}^{n}\left[\frac{180 f\ 10^{10}}{2.31 WR^{2} (RPM)^{2}}\Delta t^{2}(P_{0}-P_{n})+\Delta t V_{n-1}\right]$$

WESTINGHOUSE INSTRUMENTS
Help Solve This Equation...in Minutes!

This A-C Network Calculator, at Texas A & M College, solves complex operating and design problems such as this, in a matter of minutes or hours . . . instead of weeks or months!

Precise electrical analogies required instruments built for accuracy and *complete reliability*. Westinghouse instruments more than live up to these requirements. They also provide the co-ordinated spacesaving designs so necessary to such exacting applications.

What are your electrical measuring problems? The wide scope of the Westinghouse line, and the vast experience that backs it up, provides the electrical measuring instruments to fill *your* needs exactly . . . no matter what the problem. That's why Westinghouse instruments have long been the choice of design engineers in every field of industry.

Westinghouse instrument specialists are available in the field for consultation. Call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-40372

Westinghouse
Electrical Measuring Instruments
for Every Application

LOOK TO GENERAL CABLE

1st for Engineering

to supply High Pressure Gas Filled Pipe Type Cable for experimental field installation.

to supply High Pressure Gas Filled Pipe Type Cable for a commercial installation.

installation of any Pipe Type Cable under paved city streets.

to ship Pipe Type Cable without a temporary lead sheath.

to use ultra high viscosity oil for mass impregnation of High Pressure Gas Filled Pipe Type Cable.

to supply lengths of Pipe Type Cable half-mile and longer suitable for pulling without special full external armor.

to develop Compack Segmental Conductors now widely used in pipe type systems.

installation of High Pressure Oil Filled Pipe Type Cable without semi-stop joints or man-holes.

cable manufacturer to use extruded asphalt mastic type of corrosion protective covering on its steel Pipe Type Cable installation.

44% SUPPLIED BY GENERAL CABLE

NOW 110 CIRCUIT MILES OF PIPE TYPE CABLE FOR 100 Kv OR OVER

May 1, 1949.—For 100,000 volts and higher underground power transmission, the high pressure Pipe Type Cable Systems, gas-filled or oil-filled, dominate the scene. At this writing, the lines in service comprise a total of over 110 circuit miles.

Advance—

ON PIPE TYPE CABLE

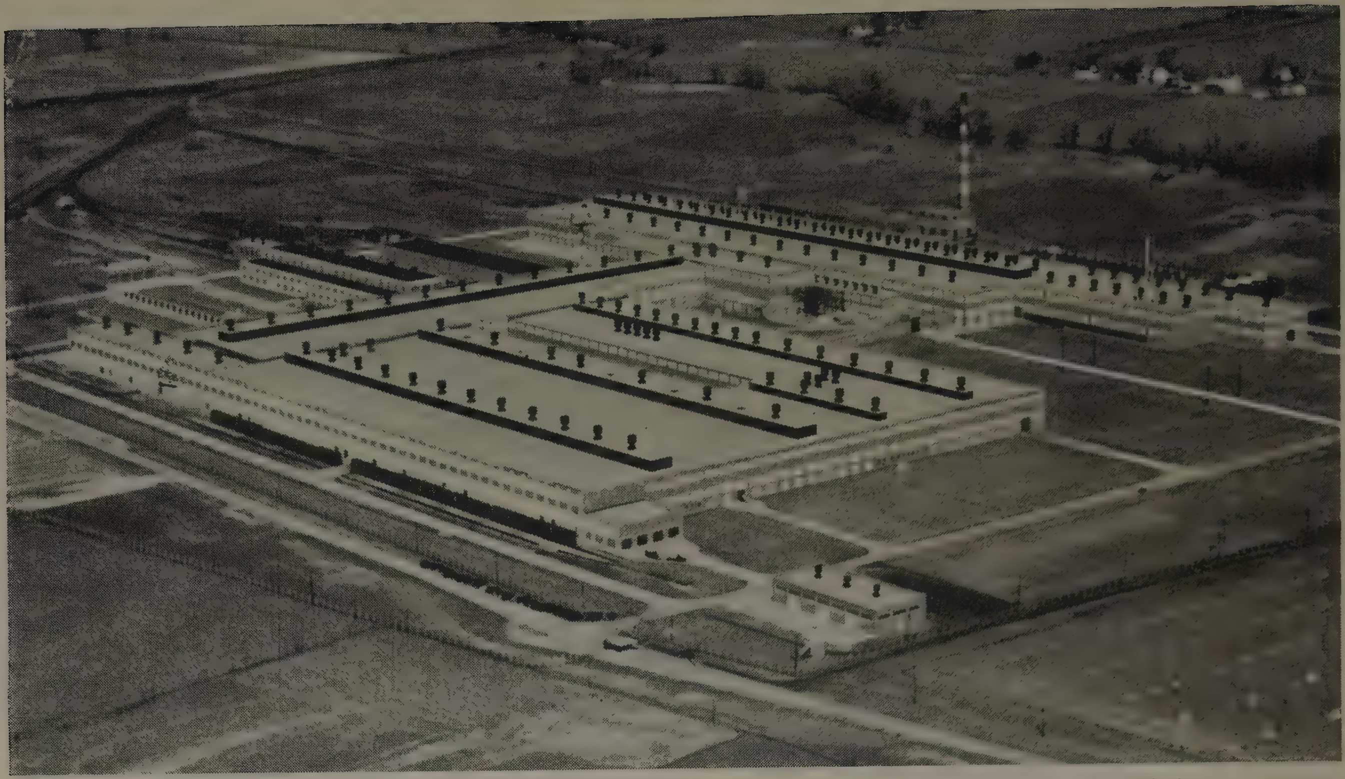
to develop and use the effective strip grip for controlling "thrust" at stuffing box glands of semi-stop joints.

cable manufacturer to share in the publishing of Test and Design Data on Thermal Characteristics of Pipe Type Cable Systems based upon field tests.

to install a Switching Surge Generator for cable tests and to publish resulting data on pipe type cable.

GENERAL CABLE
CORPORATION

SALES OFFICES IN PRINCIPAL CITIES



PERMANENTE METALS' new mill in centrally located Newark, Ohio, is one of the world's largest single installations for the production of aluminum conductor.

Here's your new source of Aluminum conductor

Deliveries start next month!

Climaxing two years of preparation, first shipments of Kaiser ACSR and Kaiser Aluminum Cable will go forward next month, July.

A full range of standard sizes and standard strandings is being produced.

Initial orders will go to REA-financed Co-ops, U.S. Bureau of Reclamation, Bonneville Power Administration, other power projects and public and private municipal utilities from coast to coast.

If you act now you may be able to take advantage of some early delivery schedules which are still open. Inquire at any office of Permanente Products' nationwide sales organization.

Permanente Metals

PRODUCER OF

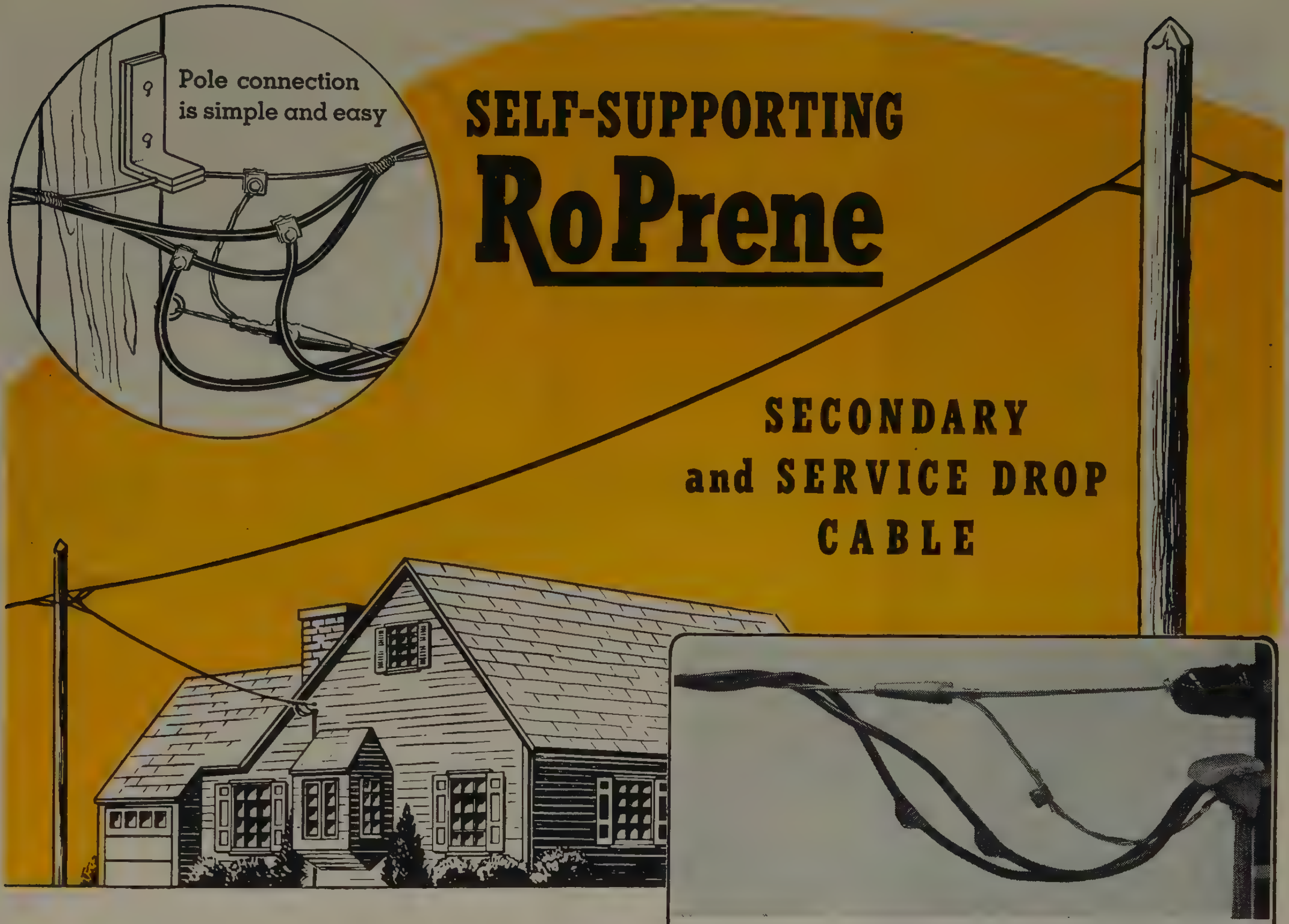
Kaiser Aluminum Cable

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BUILDING, OAKLAND 12, CALIF. . . . WITH OFFICES IN:
Atlanta • Boston • Chicago • Cincinnati • Cleveland • Dallas • Detroit • Houston • Indianapolis • Kansas City • Los Angeles
Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Portland, Ore. • Salt Lake City • Seattle • Spokane • St. Louis • Wichita

Also available through General Electric Supply Corporation, Westinghouse Electric Supply Company

SELF-SUPPORTING RoPrene

SECONDARY and SERVICE DROP CABLE


Pole connection is simple and easy

Service drop connection to house simplified with fittings and hardware commercially available.

Photo courtesy Fargo Mfg. Co., Inc.

FOR ECONOMY IN AERIAL SERVICE

As a new development of time-proven construction, RoPrene Secondary or Service Drop Cable consists of RoPrene (Neoprene) insulated power conductors, spiralled around a "straight-away" neutral conductor for mechanical support. Here is simplicity in construction, economy of installation, longer life under all weather conditions . . . plus the neater appearance of a single cable assembly compared to open wires.

These advantages can be yours:

- **Lower Cost**
- **Ease and Economy of Installation**
- **No Mechanical Stress on Power Conductors**
- **No Coverings to Rot and Festoon**
- **High Weather Resistance**
- **Reduced Maintenance**
- **Neat, Compact Appearance**
- **Versatility**

Write for more information and specification RS-4. See for yourself why, more and more, RoPrene Secondary and Service Drop Cable is becoming the accepted cable for overhead services. Available in a wide range of types and sizes.

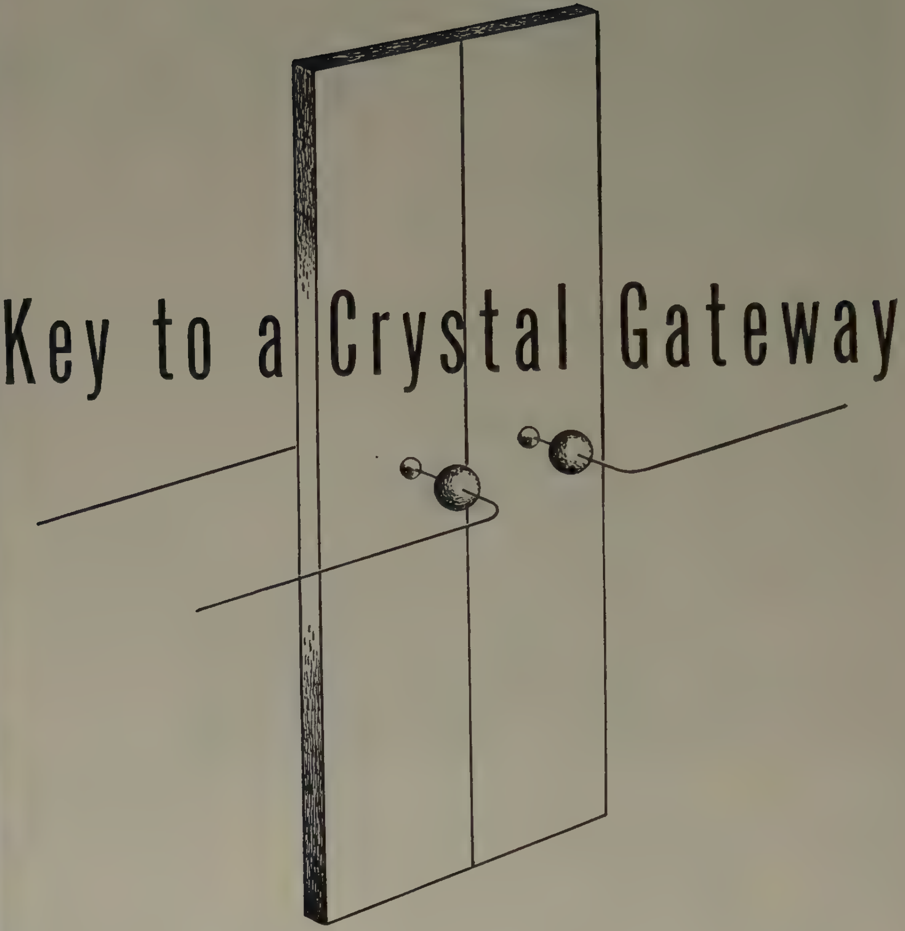
FROM BAR TO FINISHED WIRE

ROME CABLE CORPORATION
ROME • NEW YORK

ROME CABLE ROME, N.Y.

Above is a coaxial circuit crystal in its glass enclosure. At right the crystal is shown, 3½ times actual size, with connecting wires soldered in position. Weights on wires reflect energy back into crystal, so cut losses.

Key to a Crystal Gateway



How would you solder a wire to a crystal? This must be done for most of those wafer-thin plates of quartz used in electrical circuits. They play a big part in the myriad-channel telephone system that utilizes coaxial cables.

This is how Bell Laboratories scientists solved the problem: A spot of paste containing silver is deposited on the crystal and bonded to it by oven heat. The crystal is then vapor-plated with a thin layer of silver. Then a fine wire is soldered to the spot by a concentrated blast of hot air. The result is a rugged electrical connection to the surface of the crystal which does not interfere with its vibrations.

Sealed in glass tubes, the crystals are precise and reliable performers in the telephone system. Each is a crystal gate to a voiceway, separating *your* conversation from the hundreds of others which may be using a pair of coaxial conductors, at the same time.

This spot of paste, this tiny wire, this puff of air are among the tremendous trifles which concern Bell Telephone Laboratories in finding new ways to improve your telephone service.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Time

Time is the measure of all things. Few of man's inventions can stand its merciless judgment. Yet Kerite for over 90 years has thrived and spread and gained renown. Time, indeed, gives Kerite its unqualified recommendation.

THE KERITE COMPANY

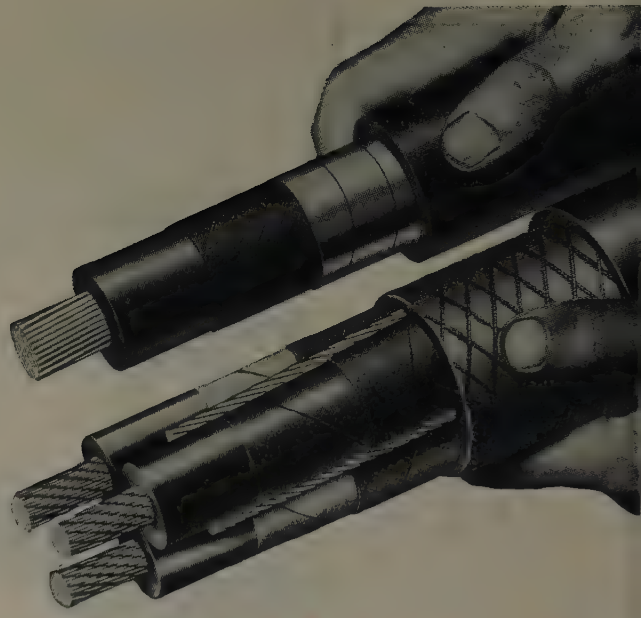
NEW YORK CHICAGO SAN FRANCISCO LOS ANGELES

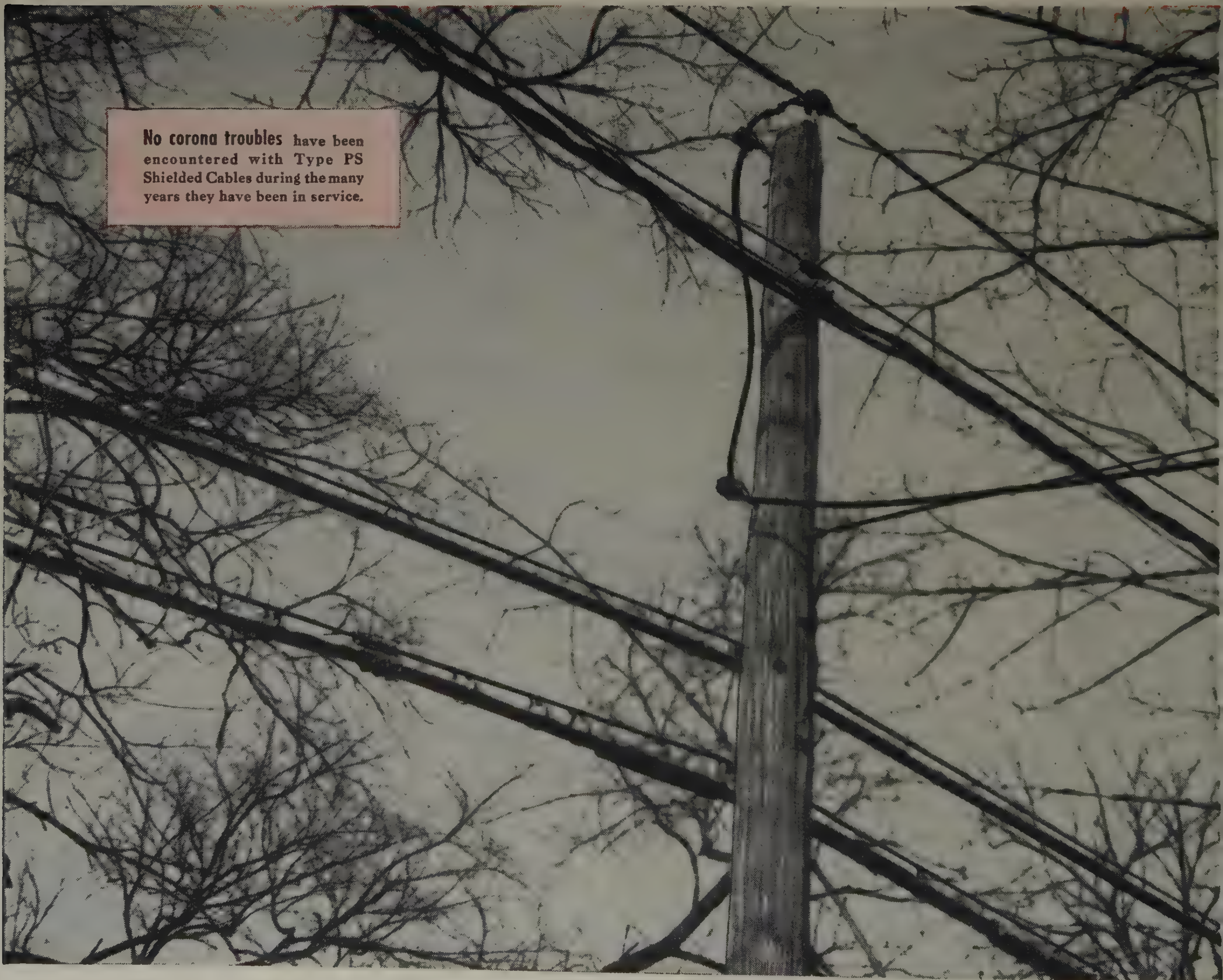
Kerite Insulation—Your Cable's Best Life Insurance

PS SHIELDING

(U. S. Patents 2,322,702 and 2,446,387)

eliminates Corona cutting in





No corona troubles have been encountered with Type PS Shielded Cables during the many years they have been in service.

OHIO BRASS COMPANY
BARBERTON DIVISION - BARBERTON, OHIO, U. S. A.
TO: PENNSYLVANIA TRANSFORMER CO.
FOR: CARNEGIE-ILLINOIS STEEL CORP.

These two 69-22-kv Pennsylvania transformers supply a total of 50,000 kva for one 70-ton electric furnace, two 35-ton furnaces, plus large blocks of power for auxiliary equipment, located at the Duquesne Works of Carnegie-Illinois Steel Corporation. Some of the highlights of these unusually heavy-duty units are... "Pre-compressed coils, detachable uni-row radiators, straight line tap changers"...

AND Ⓑ BUSHINGS....ONE OF THE FINEST COMPONENTS OF ANY TRANSFORMER

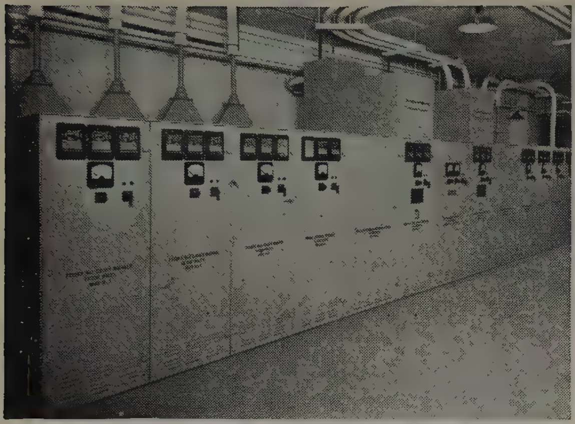
Ohio Brass

MANSFIELD, OHIO

The Philadelphia Inquirer *—chooses*

Metal-clad

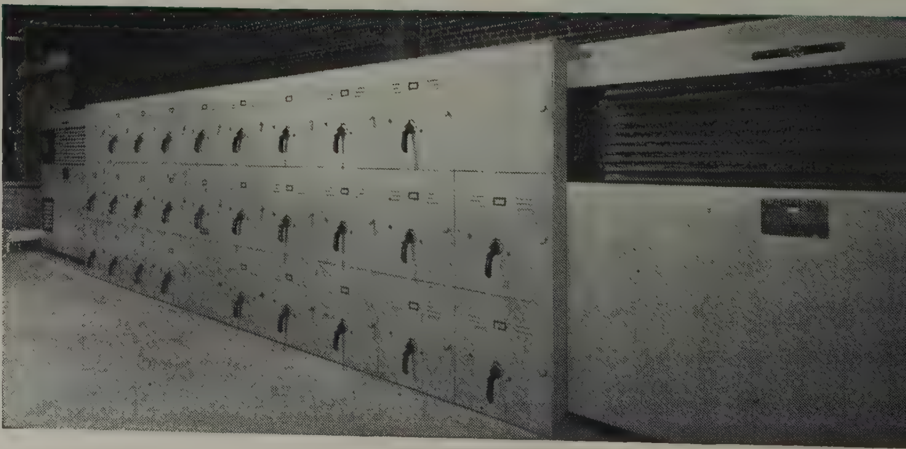
and load-center



Metal-clad switchgear handles incoming power at 13.2 kv, distributes it to four load centers. Breaker line-up (left to right): 4 feeder breakers, metering compartment, incoming line breaker, tie breaker, incoming line breaker, metering compartment, 4 feeder breakers. Metal-clad switchgear is neat in appearance, saving in space. Note absence of any protective railing or fences around unit—metal-clad construction offers operating safety to personnel.

Combination 3000-kva double-ended load center and electronic press drive control unit located on balcony. Windows on left overlook rotogravure press floor.

Two G-E 1000-kva double-ended load centers in basement of "Inquirer" Rotogravure Building. One unit is for lighting circuits, other for general power use. Transformers are modern dry-type, rated 500 kva. In right background is 13.2 kv metal-clad switchgear.



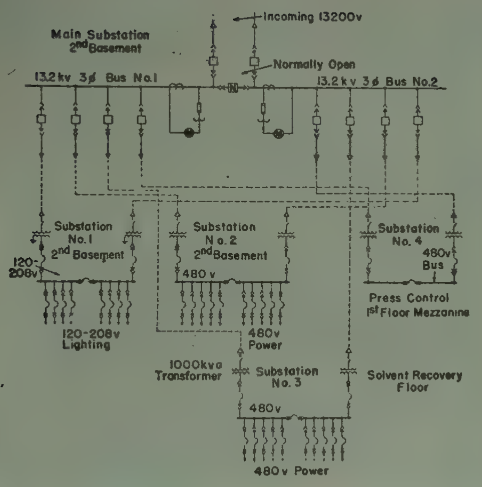
Double-ended dry-type load-center unit substation rated 2000 kva in solvent recovery room on top floor of "Inquirer" Rotogravure Building. Air circuit breakers are G-E Type AL-2-50 of 50,000 ampere interrupting rating. Horizontal grilles on transformer accentuate low, flowing lines of unit.

The "Inquirer" installation is a complete General Electric project—one source of responsibility, plus the very best in planning, engineering, manufacturing, and servicing facilities to give maximum savings and efficiency to the customer.

Switchgear unit substations

for proved service reliability!

> *"Metal-clad switchgear and load-center power distribution was the most efficient way to get continuous, reliable power for our printing operations."*
> C. W. GINSBERG, *Chief Production Engineer, Philadelphia "Inquirer"*



At the new Philadelphia "Inquirer" installation General Electric metal-clad switchgear handles the incoming 13.2 kv through 11 power breakers (2 incoming, 1 tie, 8 feeder) of 150,000 kva interrupting rating. Eight feeders distribute the power to four G-E double-ended, dry-type load-center unit substations throughout the building where the 13.2 kv is stepped down to 480 volts for utilization—right at the center of the load area. Drawout air circuit breakers are used on all unit substations. Note that costly secondary feeders are short.

This secondary selective system assures the "Inquirer" of continuous power at only slightly higher cost than a simple radial system.

Be sure to see the "More Power to America" full-color sound slidefilm "Modern Industrial Power Distribution." Ask your G-E sales representative to arrange a showing for your organization.

FOR CONTINUOUS-PROCESS OPERATIONS, such as high-speed printing, you need continuous power. And with a General Electric load-center power distribution system like the "Inquirer" installation you get continuous power.

Modern industrial power distribution systems using G-E switchgear and load-center unit substations are applicable to any industrial plant or commercial building where you want full-voltage conditions for top performance of equipment, an extremely flexible setup to take care of expanding or changing loads, adequate short circuit protection, safety to personnel, and low installation and maintenance costs. A complete system, using G-E switchgear and load centers, generally costs you less than a "piece-meal," makeshift affair.

"METAL-CLAD" means just that—the entire switchgear structure is metal enclosed, thus offering operating safety to personnel. Note that there are no self-indicting protective fences or railings around metal-clad switchgear.

The General Electric power circuit breakers, designed with adequate "IC" (Interrupting Capacity) for short circuit protection, are easily removable for inspection. This means less bother because when a breaker is temporarily out of service another can be quickly put in its place. Instruments and relays in the equipment are coordinated for positive protection of high-voltage feeders. And metal-clad switchgear is easy to install. It arrives factory-assembled—ready for final connection to power circuits.

UNIT SUBSTATIONS, compact, fully-enclosed for safety, and built from matched components, are the basic "building blocks" of the load-center system. Flexible combinations of incoming-line and secondary-circuit arrangements from 100 to 2000 kva are available. Each is a complete unit with either dry-type or Pyranol* transformers plus G-E Type AK-1 or AL-2 air circuit breakers of the drawout type. Load centers are as easy to specify as a standard machine tool.

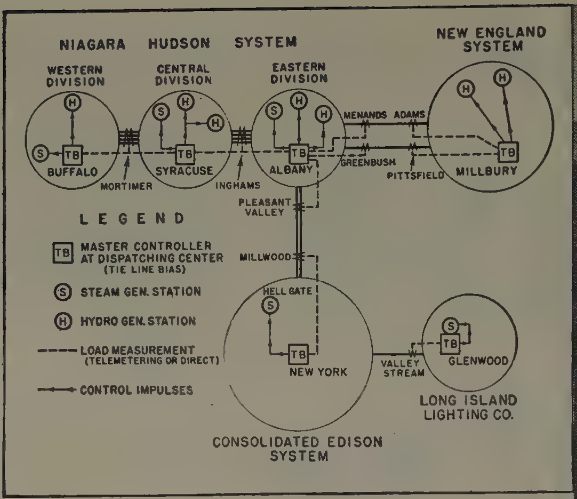
Investigate today the many advantages of using G-E switchgear and load-center unit substations in your plant for efficient, flexible power distribution. Contact your G-E sales representative for further information—and write for the helpful bulletins listed below. Apparatus Department, General Electric Co., Schenectady 5, New York.

GEA-3083	Metal-clad Switchgear
GEA-4966	Low-voltage Metal-enclosed Switchgear
GEA-3592	Load-center Unit Substations
GEA-3758	What Load-center Power Distribution Can Do for You
GEA-4507	Interlocked-armor Cable for Primary Circuits
GEA-4352	Flamenol* Cable for Secondary Circuits

**Reg. U.S. Pat. Off.*

GENERAL ELECTRIC

860-38



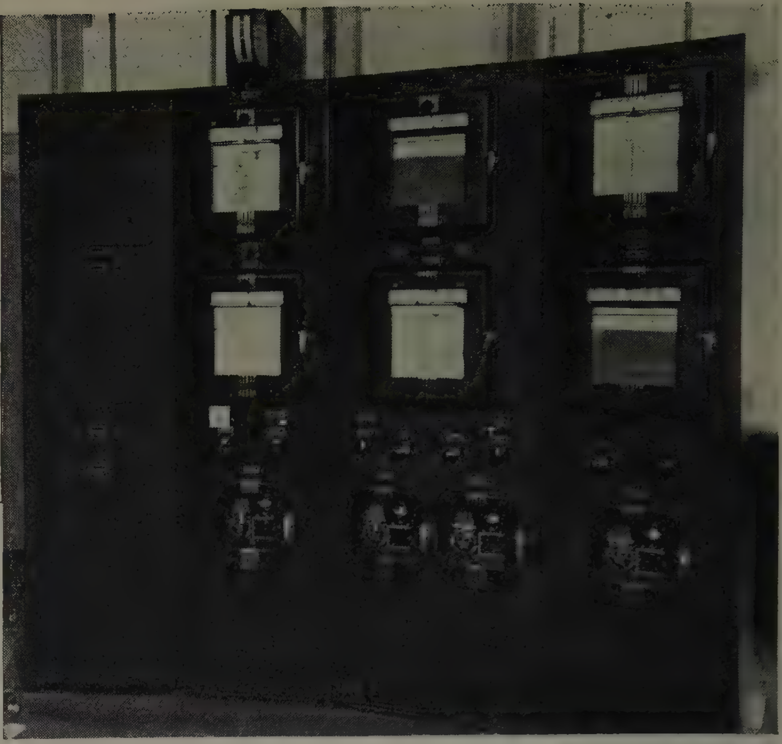


Diagram shows load-frequency control areas of the Northeast Interconnection. At right, the system's L&N master load-frequency equipment for centralized control of tie line and station loading.

Interconnection Carries Heavier Tie Loads With Help of L&N Load-Frequency Control

The 7-million-kw Northeast Interconnection* which supplies electric power to large areas of New York State and New England, relies on tie-line bias control for load-frequency regulation of all the ties indicated in the above diagram—and the System likes the results.

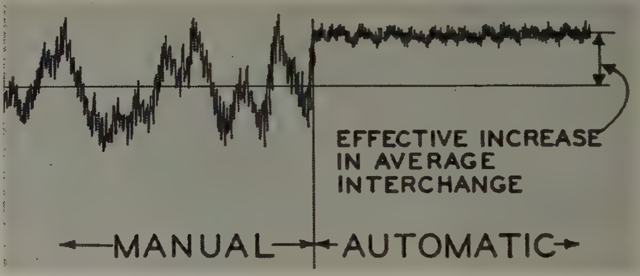
As with other interconnections using the bias method, this network "went through all the early stages" of control—first flat frequency, then selective frequency, then tie-line bias. They say "we have continued to expand (tie-line bias control) within the respective Systems, to provide better and better control of the load and therefore better frequency control of the whole interconnection".

"Good Neighbor Policy" of Stations

The Control permits each generating station to be a good electrical neighbor to the others in its interconnection. While many stations operate on the basis of dispatched load, each area is responsible for correcting its own load variations, and scheduled transfers can be worked out between stations for economy or emergency reasons.

Ties Carry Heavier Loads

Regarding the problem of meeting the area's power needs, the Interconnection finds much help in the bias control. "If the interchange were permitted to vary," they say, "a greater operating margin would have to be maintained, between the average tie-line load and ultimate carrying capacity. The control reduces fluctuations, therefore closes the gap between actual load and available capacity". This situation is diagrammed in the accompanying illustration.



Visualization of the load-carrying increase of a tie line possible with L&N Load-Frequency Control for tie-line-bias regulation.

L&N equipment is available not only for tie-line load control, but for any other type of regulation. We will be glad to send you a general description of the instruments, but if you have a specific problem, we suggest you give us the significant details so that we can more clearly present the pertinent facts. Address Leeds & Northrup Company, 4962 Stenton Avenue, Philadelphia 44, Pa.

---

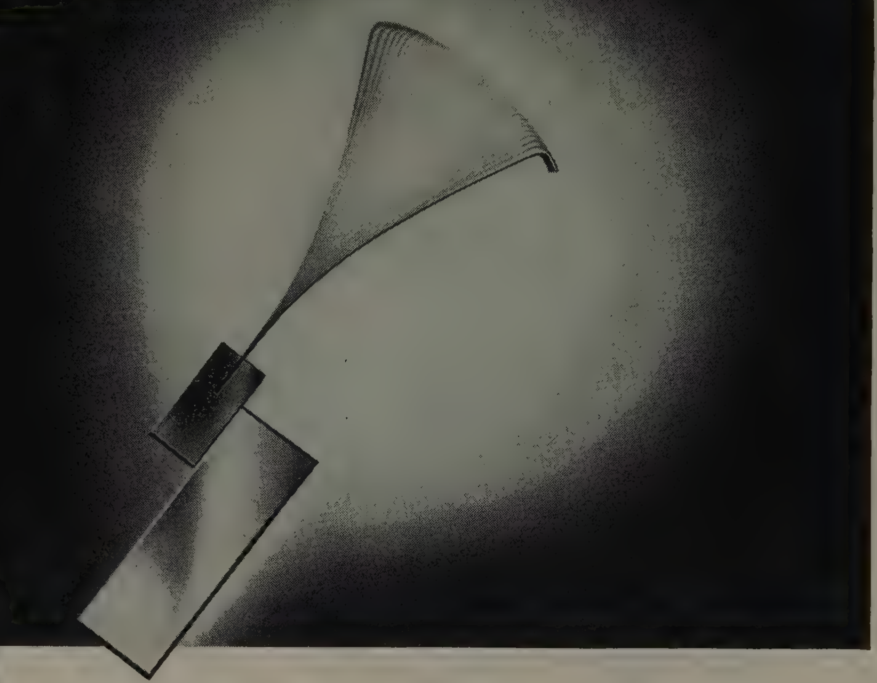
*See "Load-Frequency Control on the Northeast Interconnection" by McCormack & Metcalf in *Electric Light & Power*, Feb. 1949. Reprint N-56(2) from L&N on request.

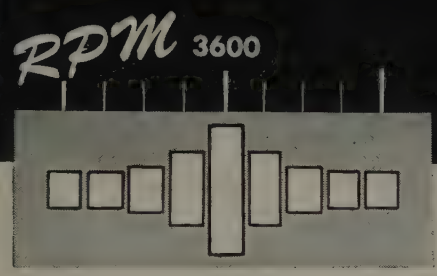
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

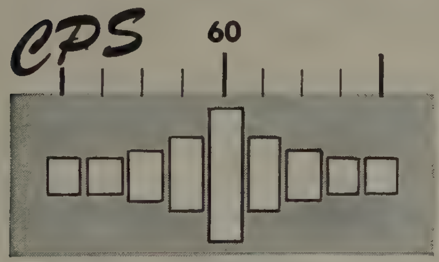
Jrl. Ad ND44-56-461(1)

Resonance is the Reason . . .

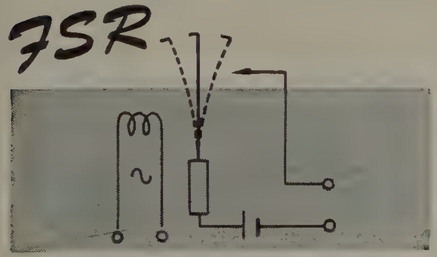




TACHOMETER (Revolutions per min.)



FREQUENCY METER (Cycles per sec.)



FREQUENCY SENSITIVE RELAY

The natural phenomenon of resonance in a steel reed provides the operating principle for a unique series of instruments that measure speed, frequency and rate of vibration.

Of the utmost simplicity, Frahm Resonant Reed Tachometers and Frequency Meters contain a set of steel reeds—with each reed tuned to a definite period of vibration. When minute vibratory impulses enter the reeds through the frame on which they are mounted, individual reeds come into resonance and clearly indicate the frequency of vibration in cps or rpm. It's as simple as that!

Frahm Tachometers can be mounted directly on turbines and other equipment—and require no electrical, gear or belt connections. Portable types are also available . . . operate merely by contact. Various speed ranges can be covered from as low as 900 to as high as 100,000 rpm or vpm.

Frahm Frequency Meters, portable or permanent, indicate alternating current frequency from as low as 15 to as high as 1500 cps. A small electro-magnet actuates the reeds.

Frahm Frequency-Sensitive Relays operate either *on* a given frequency impulse or upon slight deviation *from* a specific frequency. They are particularly appropriate where a frequency impulse can be superimposed, such as on a d-c circuit.

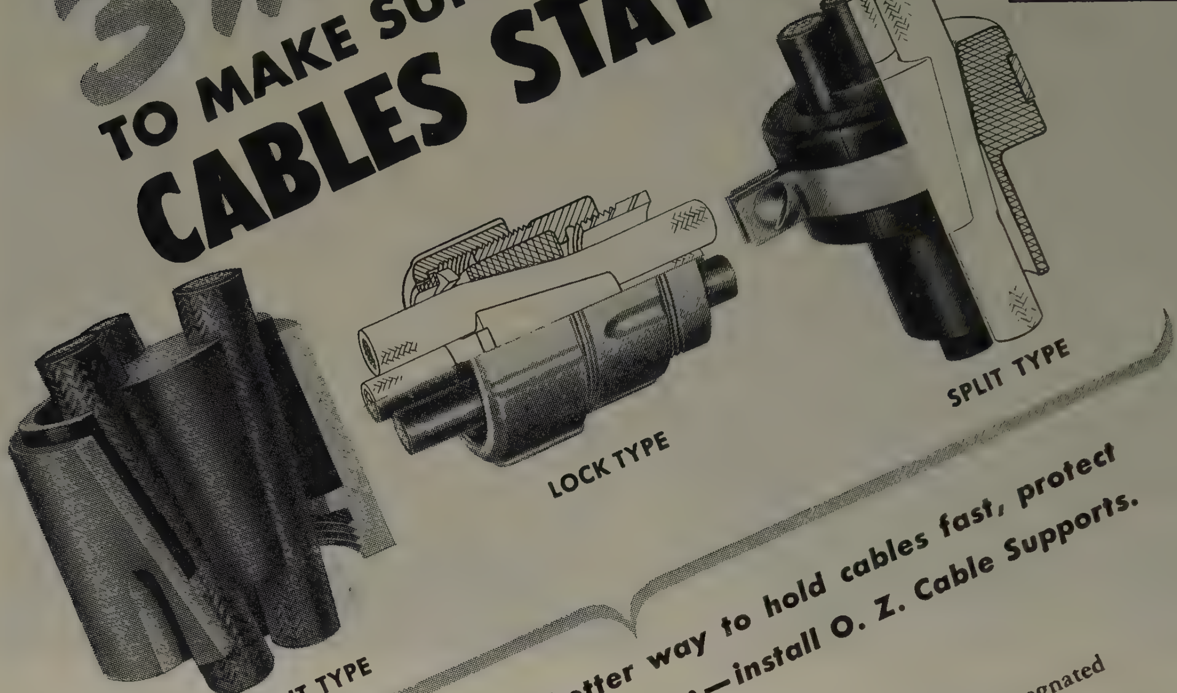
We will gladly send you full details on any or all of these Frahm Resonant Reed Instruments and their applications. The following bulletins are available:

Frahm Tachometers—Bulletin 31-EE.
Frahm Frequency Meters—Bulletin 32-EE.
Frahm Sensitive Relays—Information on Request.

JAMES G. BIDDLE CO.
Electrical & Scientific Instruments
1316 ARCH STREET, PHILADELPHIA 7, PA.

3 WAYS TO MAKE SURE CABLES STAY PUT!

National Electrical Code paragraph 3014 specifies intervals at which cable supports must be used in vertical raceways.



When you're looking for a better way to hold cables fast, protect connections against pull or vibration—install O. Z. Cable Supports.

WHY?

BECAUSE O. Z. makes the *only* cable supports with one-piece impregnated maple plugs, machined to the exact wire size.

BECAUSE there is an O.Z. support for installation before or after pulling wire.

BECAUSE the serrated O. Z. liner provides a *positive* grip when plug is wedged home.

BECAUSE you can choose from three basic types the *best* support for your job—

1. **CONDUIT TYPE** for fast, easy installation on vertical runs. Screws directly on conduit. Malleable iron body grooved for tightening with screwdriver.
2. **LOCK TYPE** for use in *any* position. Threaded collar pressing against plug assures vibration-proof support under all conditions.
3. **SPLIT TYPE** for quick changeover jobs where cable is already installed. Body halves placed around cable, steel band fastened, and assembly placed on top of conduit.

There are thousands of O.Z. products designed to help you put power where you want it, and your O.Z. distributor is the man to see about them. Send for illustrated catalog.

5305

And Remember — They're O. K. If They're O. Z.

CONDUIT FITTINGS • CABLE TERMINATORS • CAST IRON BOXES
GROUNDING DEVICES • SOLDERLESS CONNECTORS • POWER CONNECTORS

O.Z. ELECTRICAL MANUFACTURING COMPANY, INC.
262 BOND STREET • BROOKLYN 2, N. Y.

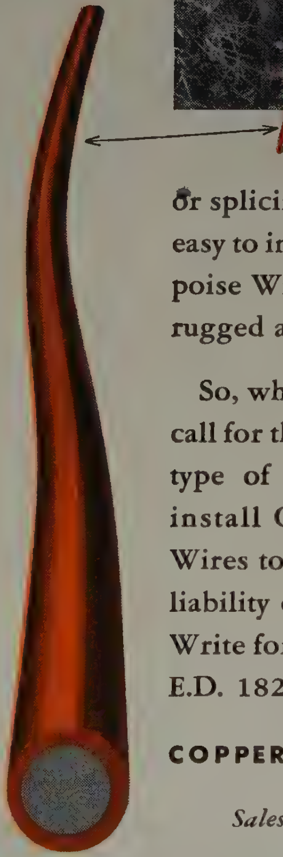
ON HIGH VOLTAGE
TRANSMISSION LINES

COPPERWELD COUNTERPOISE WIRES
REDUCE Flashovers

Where soil conductance is poor, the use of Copperweld* Counterpoise Wires to supplement tower grounds assures better lightning protection.

Connected to the tower legs and buried in the earth, Copperweld Counterpoise Wires reduce the resistance of tower grounds and increase the coupling between overhead ground wires and conductors—thus minimizing flashovers and possible outages of the line.

The thick copper covering of Copperweld Counterpoise Wires provides an excellent high conductivity path to earth and the strong alloy steel core permits long lengths to be "plowed in" without breakage or splicing. Rust-proof, pliable and easy to install, Copperweld Counterpoise Wires are nevertheless tough, rugged and not susceptible to theft.



So, whether your local conditions call for the "parallel" or "crowfoot" type of grounding arrangement—install Copperweld Counterpoise Wires to improve the operating reliability of your transmission lines. Write for Engineering Data Bulletin E.D. 1824.

COPPERWELD STEEL COMPANY
GLASSPORT, PA.
Sales Offices in Principal Cities

*Trade Mark

Copperweld
TRADE MARK
COUNTERPOISE WIRES

Allis-Chalmers Builds for Electric Utility Progress —

FIRST AID for

Production Upped 5 Times on Allis-Chalmers ⅝% Step Regulators . . . to Help You Keep Pace With Load Growth!

THIS 500% INCREASE in regulating equipment has paid-off for many utilities. Shortened delivery has put more of these regulators to work where they were needed—has helped ease the problem of overloaded feeders.

By closely regulating voltage, Allis-Chalmers ⅝% step regulators not only increase the load capacity of the feeder, thereby increasing revenue . . . but they also improve customer service. Appliances and equipment are spared the poor operation caused by low or fluctuating voltages.

Years ago Allis-Chalmers led the development of a narrow band width, lower excitation regulator. Today, Allis-Chalmers ⅝% step regulators regulate over 5,000,000 kva . . . maintain voltages within ±1%, and operate at ⅓ the excitation required by other types. (Specific information is available.)

Ask your A-C sales representative about other important features of Allis-Chalmers regulators—the *Vari-Amp* adjustment that permits as many as five current ratings . . . the long-life *Elkonite RS-1045 contacts* . . . the *Quick-Break* mechanism that snubs fast-moving parts to a standstill without shock. Or write for bulletins 01B6065A and 01B6056B.

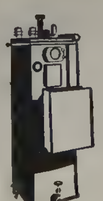
* * *

Increased production of this critically needed equipment has been achieved through modern assembly-line manufacture. It is an example of how Allis-Chalmers recognizes and strives to build for the needs of the electric utility industry.

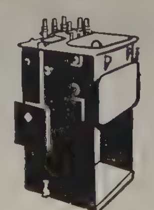
ALLIS-CHALMERS, 931A SO. 70 ST.
MILWAUKEE, WIS.

A 2628

Vari-Amp is an Allis-Chalmers Trademark



DFR — Single phase regulators . . . provide ±10% regulation in 2400, 4800 and 6900 volt ratings.



AFR — Three phase regulators . . . for feeders from 2400 to 69,000 volts, up to 25,000 kva.

ALLIS-

Pioneers in Power and

Overloaded Feeders

CHALMERS

Electrical Equipment From Generation Through Utilization

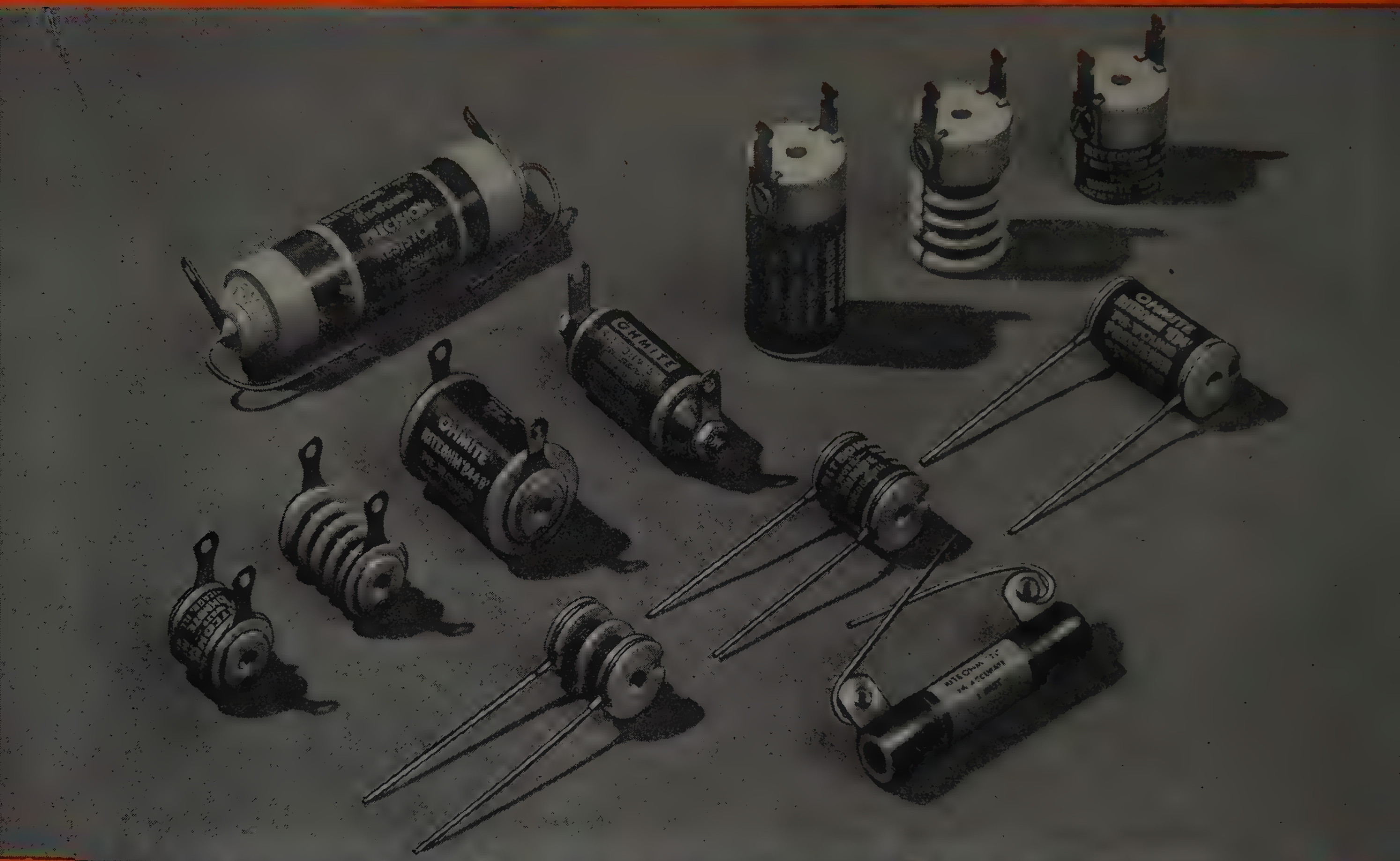
Hermetically Glass-Sealed Riteohm Series 90

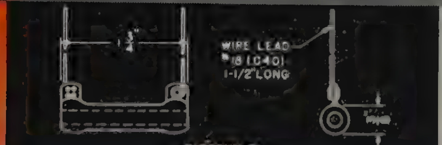
NON-INDUCTIVE
PIE WOUND
±1% ACCURATE

For Accuracy...

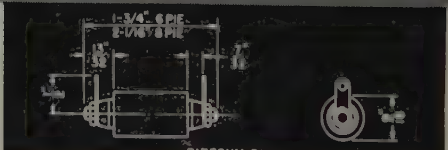
OHMITE

RITEOHM PRECISION RESISTORS

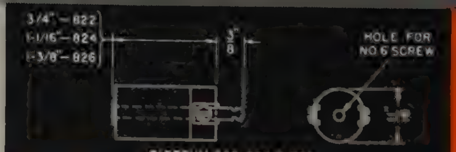




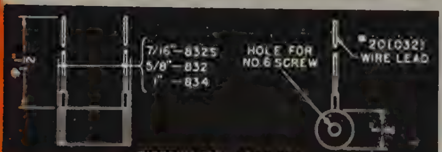
RITEOHM 71



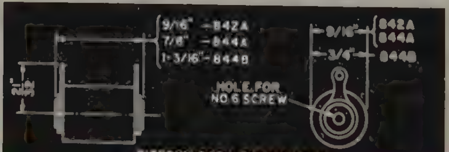
RITEOHM 81



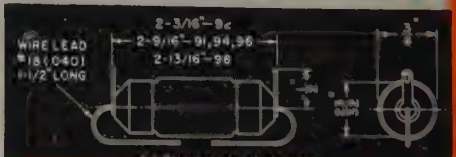
RITEOHM 822, 824 & 826



RITEOHM 832S, 832 & 834



RITEOHM 842A, 844A & 844B



RITEOHM 91, 92, 94, 96 & 98

However critical the application, Ohmite Riteohm Precision Resistors assure reliability and consistent accuracy. They are ideal for use in voltmeter multipliers, laboratory equipment, test sets, and in electronic devices requiring extremely accurate resistance components. Available from stock in ½-watt and 1-watt units in a wide range of values and types . . . or made to order . . . as listed in Bulletin 126.

Write for Ohmite Precision Resistor Bulletin No. 126

OHMITE MFG. CO.
4803 Flournoy St., Chicago 44

Be Right with... **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES

STOP, LOOK AND READ HOW EASILY **LVD Flex-a-power**

CUTS INSTALLATION COST
KEEPS MAINTENANCE LOW
GIVES MAXIMUM BUSWAY FLEXIBILITY

Because Trumbull LVD FLEX-A-POWER® is made in pre-fabricated units, you save money with this system these three ways.

The units are easily and quickly put together . . . no special engineering skill is required for installation. This means that many expensive time and labor costs are eliminated for a *lower "installed cost."*

Not only is LVD pre-fabricated, but it is pre-engineered so that you can predetermine electrical performance before actual installation. This advantage is an important factor in minimizing voltage drop and in keeping machine efficiency high.

LONG-LIVED MATERIALS —

Another advantage — LVD FLEX-A-POWER materials do not deteriorate even under the most severe operating conditions, thus assuring years of satisfactory service *without costly maintenance repairs.*

ADAPTABLE, "TAKE-APARTABLE" —

LVD FLEX-A-POWER is readily adaptable to any power distribution problem you may have. Fast to install, its convenient "take-apartability" allows you to relocate your LVD system without replacing a single part!

Learn more about the many advantages of LVD. Write for Circular TEC 152 today. THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn.

Men Who Observe the Best Electrical Practice Make It a Practice to Use

TRUMBULL (T) ELECTRIC

TRUMBULL'S TRAINLOAD OF NEW PRODUCTS

Type 1301-A Low-Distortion Oscillator

Here's Your "PROOF-OF-PERFORMANCE"

AS ANNOUNCED by the Federal Communications Commission,* effective August 1, 1949 all a-m and f-m broadcast stations will be required to make proof-of-performance checks of over-all noise and distortion of the complete station at least once a year.

Many stations already make these measurements at frequent intervals as routine operating maintenance to insure the continuous high-quality service the modern transmitter system is capable of supplying.

General Radio instruments for these measurements have been available for some time, and are in regular use by the leading stations where this equipment has given accurate, convenient-to-use and trouble-free service.

The G-R Type 1932-A Distortion and Noise Meter meets all of the F.C.C.'s requirements for measurements of this type for both a-m and f-m services; the Type 1301-A Low-Distortion Oscillator is the ideal companion unit for use with the Type 1932-A. Both of these instruments are relay-rack mounted and can be supplied in panel finishes to match most existing installations.

TYPE 1932-A DISTORTION & NOISE METER

For measurements of sine-wave voltages, distortion and noise throughout the audio range. Over-all pass-band of the voltmeter circuit extends to 45,000 cycles, thus including all noise and distortion products contained in this range; particularly the 3rd harmonic of a 15,000-cycle test is included.

This instrument is continuously adjustable and can be set to any frequency quickly since it has only one main tuning control plus a small trimmer. With it measurements can be made on a-f distortion in radio transmitters, line amplifiers, speech amplifiers, speech input equipment to lines; noise and hum levels of a-f amplifiers, wire lines to the transmitter, remote pick-up lines and other station equipment.

Full-scale deflections on the large meter read distortions of 0.3, 1, 3, 10 or 30 per cent; range for carrier noise measurements extends to 80 db below 100% modulation, or 80 db below an a-f signal of zero dbm level. The a-f range is 50 to 15,000 cycles, fundamental, for distortion measurements and 30 to 45,000 cycles for noise and hum.

Type 1932-A Distortion and Noise Meter: **$575.00**

TYPE 1301-A LOW-DISTORTION OSCILLATOR

Especially designed for rapid measurements, this highly-stable oscillator has exceptionally low distortion. By means of push buttons, 27 fixed frequencies between 20 and 15,000 cycles may be selected in logarithmic steps. Any frequency between steps can be obtained by plugging in external resistors. The distortion over the entire range will not exceed the following percentages: with 5,000-ohm output, 0.1% from 40 to 7,500 cycles; 0.15% at other frequencies. With 600-ohm output 0.1% from 40 to 7,500 cycles; 0.25% from 20 to 40 cycles and 0.15% above 7,500 cycles.

The oscillator is calibrated to within ±(1½% + 0.1 cycle); the calibration is not affected by changes in load or plate supply voltage; drift is less than 0.02% per hour after a few minutes operation. The operation of the oscillator is unaffected by ordinary climatic changes.

Type 1301-A Low Distortion Oscillator: **$395.00**

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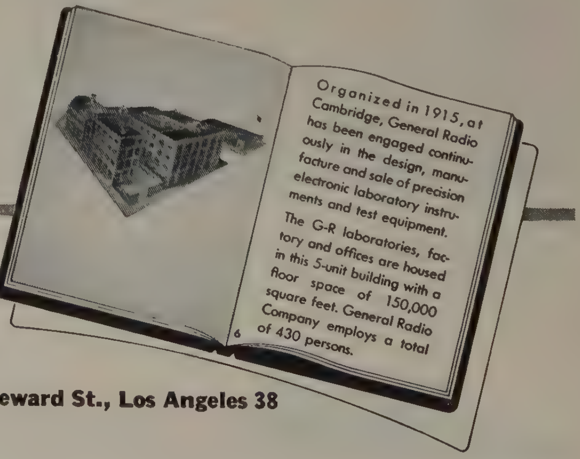
*F.C.C. Rules and Regulations, Sections 3.254 and 3.46, as amended



Organized in 1915, at Cambridge, General Radio has been engaged continuously in the design, manufacture and sale of precision electronic laboratory instruments and test equipment.

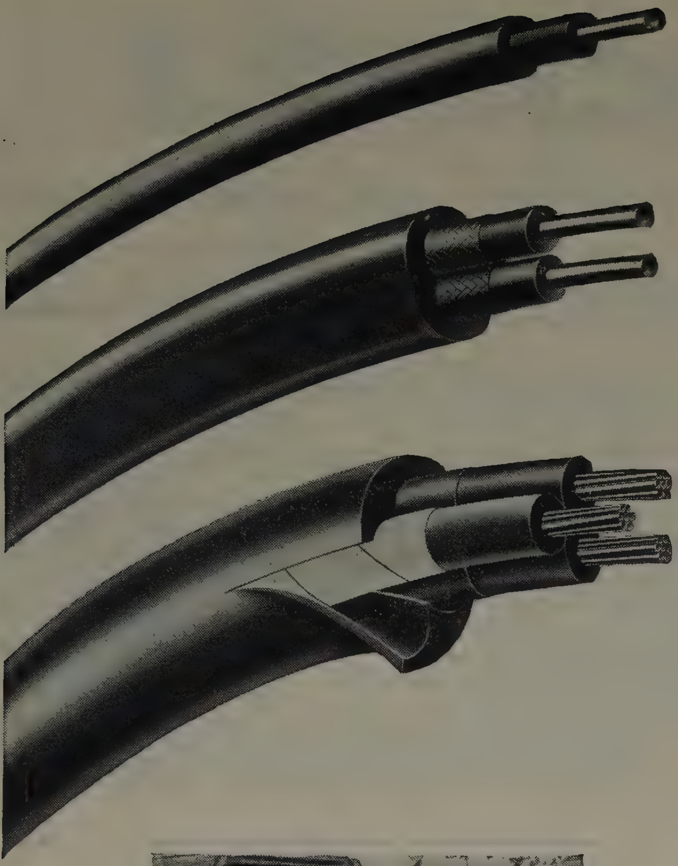
The G-R laboratories, factory and offices are housed in this 5-unit building with a floor space of 150,000 square feet. General Radio Company employs a total of 430 persons.

6

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6   920 S. Michigan Ave., Chicago 5   1000 N. Seward St., Los Angeles 38



Choose One Type of Power Cable... Use it Three Ways

Pick Durasheath for power distribution: small size or large . . . one, two or three conductors . . . to carry from 0 to 5,000 volts. Then use this type in any installation you like: buried directly in the ground . . . in conduit . . . suspended from poles . . . or in a run that includes all three. Following are some of the characteristics of Durasheath that give it this versatility:

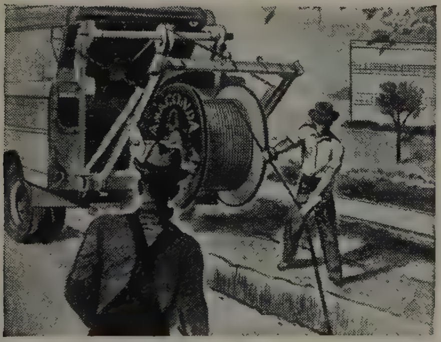
Durasheath is *unaffected by electrolysis,* corrosion and extremes in temperature.

High resistance to oil, flame, abrasion, cutting, impact and the moisture, acids and alkalies found in the soil.

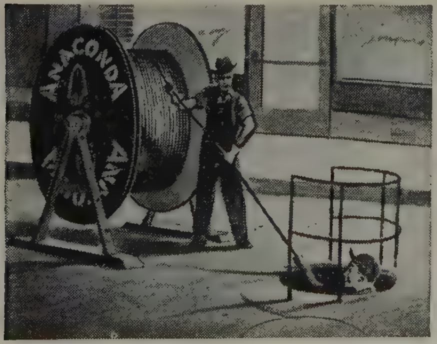
Light weight — greater strength.

More flexible, easier to handle.

For power distribution between industrial plants, in street lighting systems, airports, mines, railroad signal systems, farm buildings and real estate developments — to mention a few — use Durasheath, the all-purpose cable. Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 49421



UNDERGROUND. Toughness of neoprene jacket assures long life of Durasheath when installed directly in the ground.



IN DUCT. Moisture, oil, acid resistance of neoprene jacket make Durasheath an ideal cable for this application.

IN THE AIR. In single or multi conductors, Durasheath truly is a one-type cable for all-type use.

Anaconda Durasheath

ANACONDA
from mine to consumer
REG. U.S. PAT. OFF.

THE ALL-PURPOSE CABLE

STACKPOLE

CARBON • GRAPHITE • MOLDED METAL

Engineering News

FIRST AID FOR A LOT OF CONTACT TROUBLES

Having trouble getting contacts for long life and low contact resistance on continued operations where heavy arcs exist, or under closed conditions? Then Stackpole Silver-Tungsten Contacts are probably the answer to your problem—whether it applies to a circuit breaker, motor controller, transformer protective device, aviation relay, contactor or similar equipment that requires an extremely durable contact.

TYPICAL STACKPOLE SILVER TUNGSTEN GRADES

Grade	Composition % Silver	Cross Breaking Strength Lbs. per Sq. in.	Hardness Rockwell Superficial	Density	Electrical Conductivity Ag = 100	Contact Resistance Estimated Ag = 100
FW56	70	57,000	15T75	12.0	75	120
FW49	50	82,000	30T56	13.2	55	150
FW41	35	108,000	30T72	14.6	45	200
FW34	32	110,000	30T70	14.7	40	250

Only a few standard types are available. Best results are obtained by laboratory testing of contact mixes containing different percentages of silver and graphite. These tests are made on the actual device under operating conditions—a service Stackpole gladly renders to makers of original electrical equipment. Write for details.

NEW! INEXPENSIVE 3 AMPERE SNAP SWITCHES

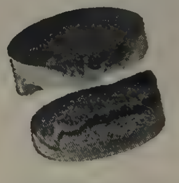
These sturdy little switches meet the need for units having sufficient current-carrying capacity for electrical toys, appliances and similar equipment. SS-26 is single-pole, single-throw and SS-26-1 is single-pole, double-throw. Both are rated at 3 amperes at 125 V. AC or 1 ampere at 125 V. DC. Both are Underwriters approved. Designed and constructed for long, dependable service, they are available at low cost. Samples on request to quantity users.

PUMP SHAFT MECHANICAL SEALS

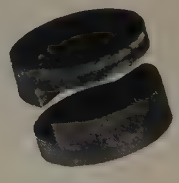
Pump or compressor seals molded from suitable mixtures of carbon, graphite or carbon-graphite offer distinct advantages, for many applications. In contrast to the ordinary "packing type" seal, these molded Stackpole *mechanical* units seal the shaft tightly and *without any wearing surface bearing on it.* This prolongs shaft life while assuring greater operating efficiency. In addition, Stackpole molded seals are unexcelled for difficult applications where a tight seal must be maintained under high pressure conditions.

Mechanical seals can be molded to close tolerances and to a variety of shapes. As amply proved by Stackpole's broad experience, they are ideal for many different shaft sealing applications. Write, giving details of your application for specific recommendation.

WELDING OR BRAZING CARBON ELECTRODES *that last 3 to 4 times as long*



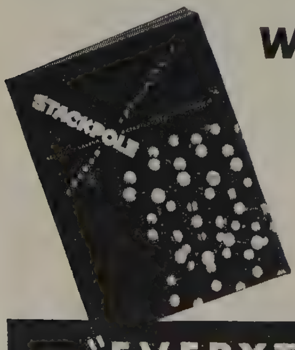
UNTREATED
after 500 brazing operations



STACKPOLE "F" TREATED
after 1300 similar operations

Here's where you can make a substantial saving, reduce machine "outage" time while tips are being dressed or changed, increase welding and brazing efficiency.

Stackpole's famous "F" treatment (which minimizes oxidation) produces tips that operate at temperatures above red heat, require dressing less than one-third as often, and last from 3 to 4 times longer than ordinary, untreated tips. On a typical high-temperature job where conventional carbons were changed hourly, Stackpole "F" treated carbons lasted all day and required dressing only about one-third as often. Write for samples, stating size and shape. Mention company connection.



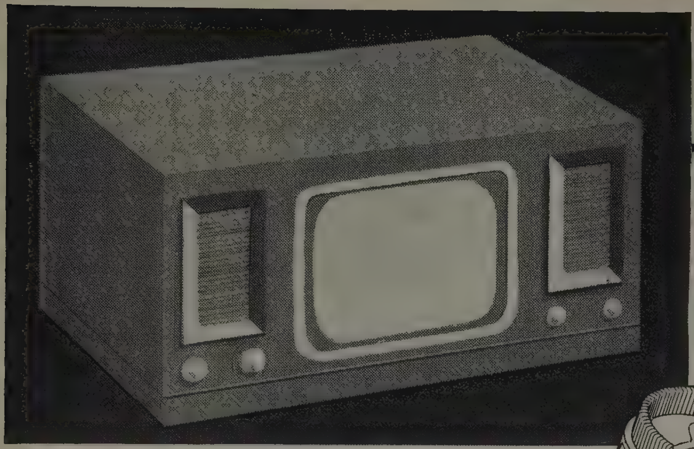
Write for this CARBON SPECIALTY ENGINEERING DATA BOOK

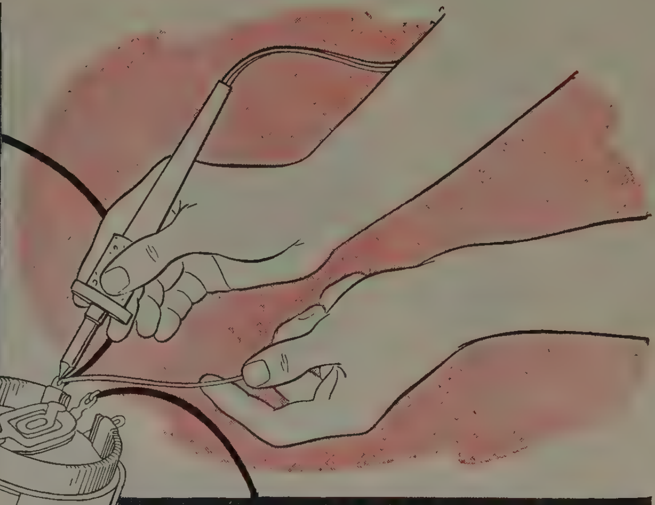
More than a catalog, Stackpole Booklet 40 contains a wealth of data to help you evaluate the electrical, mechanical or chemical advantages of carbon, graphite or carbon-graphite on a long list of applications. Write for copy today on your company stationery.

STACKPOLE CARBON COMPANY • ST. MARYS, PA.

"EVERYTHING IN CARBON BUT DIAMONDS"

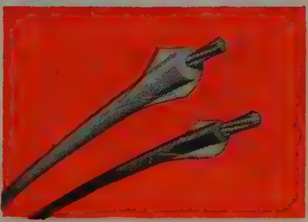
Hook-up wire jacketed with HEAT-RESISTANT DU PONT NYLON PLASTIC approved for temperatures to 90°C.





NEW NYLON-JACKETED WIRE

for Radio, Electrical and Electronic Devices



HEAT-RESISTANT nylon-jacketed wire, made by Gavitt Manufacturing Co., Brookfield, Mass., in two types: 1/64″ wall thickness with 300-volt rating, and 1/32″ wall thickness with 600-volt rating—both with 5-mil extruded nylon jackets.

Small diameter, light weight, and flexibility among the many *extra* advantages of nylon heat-resistant jackets

The first thermoplastic-insulated wire to receive Underwriters' approval for use in electrical appliances at temperatures to 90°C. is now being made by covering the wire with a jacket of Du Pont nylon plastic.

Only a thin coating of lightweight nylon is needed to provide this added heat-resistance, instead of the heavy asbestos jacket formerly used. Thus this wire has the advantages of *light weight, small diameter,* and *flexibility.*

And in addition to raising the heat-resistance of the primary insulation, nylon provides improved resistance to oils, chemicals, and abrasion . . . plus *extra smoothness* for easier pulling.

To help you make better products

Today, manufacturers of electrical wire are finding that a jacket of nylon reduces deformation under load at elevated temperatures, and they are using this property to help meet the increasing demand for heat-resistant wiring. Nylon can help you make many electrical products better. This Du Pont plastic can be extruded over bare wire or over primary insulation. It can be molded into thin sections and intricate shapes, and around metal inserts.

How can you take advantage of its unusual properties? To see how other manufacturers are using nylon profitably, and for valuable information on molding and extrusion of nylon, write for free booklets.

E. I. du Pont de Nemours & Co. (Inc.), Plastics Department.

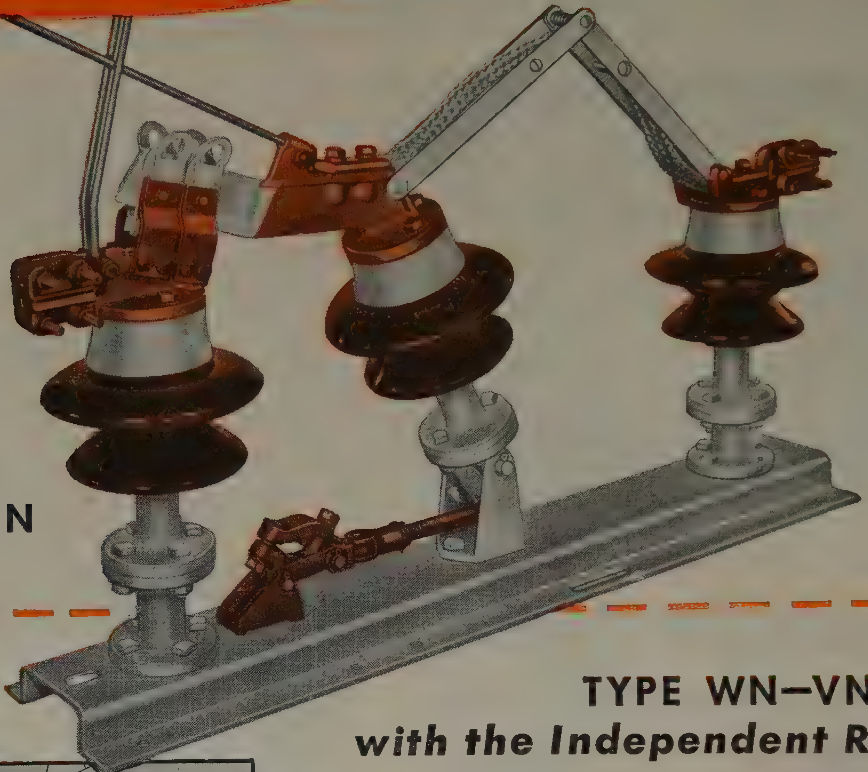
MAIN SALES OFFICES: 350 Fifth Avenue, New York 1, N. Y.; 7 So. Dearborn Street, Chicago 3, Illinois; 845 E. 60th Street, Los Angeles 1, California.

DU PONT

Plastics

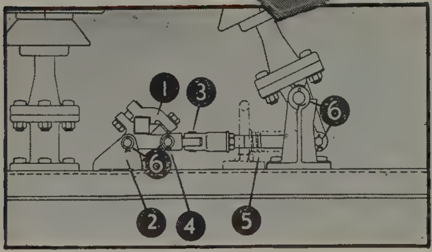
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

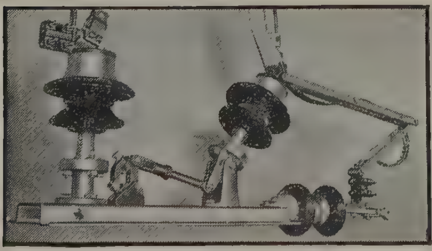
CHANCE Power



TYPE WN

TYPE WN—VN
with the Independent Rockershaft





TYPE VN

Chance Tilting Insulator Switches make positive contact on all phases because the Rockershaft operates independently of the tilting insulator. Not affected by angular distortion . . . each blade in a three-pole switch makes a complete contact without affecting the other two blades.

- **EASILY INSTALLED AND ALIGNED . . .** Removable clamps (1) permit shaft to be laid in position after switch units are mounted. Rockershaft base (2) pivots to aid alignment with operating shaft. Pivot base and universal joint (3) compensate for warpage of supporting structure.
- **POSITIVELY NO SLAMMING . . .** Special toggle joint (4) prevents slamming of blade when closing.
- **EXTRA LEVERAGE** of Rockershaft gives smooth, easy operation with ample power to break ice accumulation. Bumper spring (5) cushions operating movement and helps start closing motion.
- **NO OILING . . .** All working joints are fitted with Oilite bearings (6) for smooth, lifetime operation.
- **UNIVERSAL TERMINALS . . .** Reversible switch terminal blocks accommodate cable ranging from No. 4 solid copper to 600,000 C. M. or ½″ and ¾″ I. P. S. tubing.

C492

ABC INDUSTRIES

You know it's RIGHT

A. B. CHANCE COMPANY—CENTRALIA, MO.

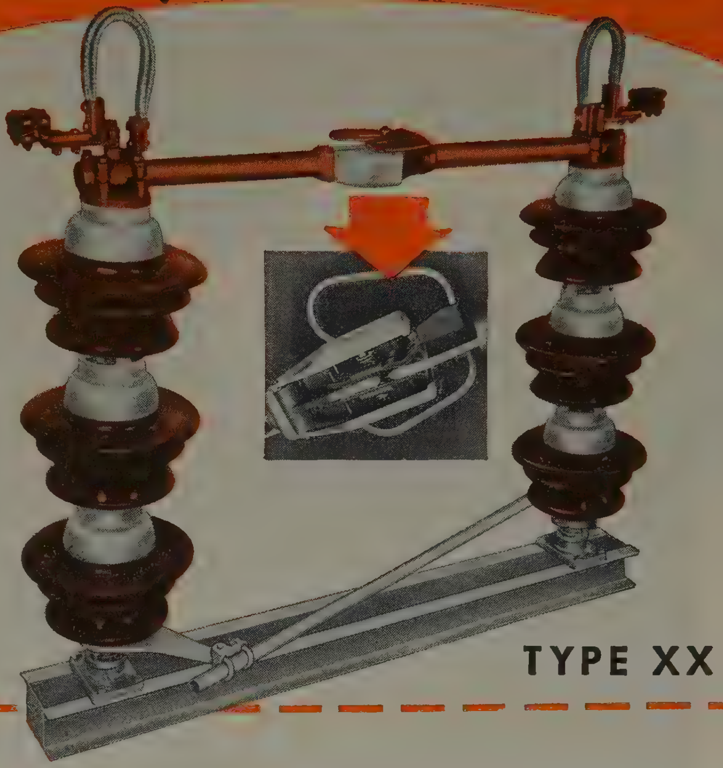
Switching Equipment

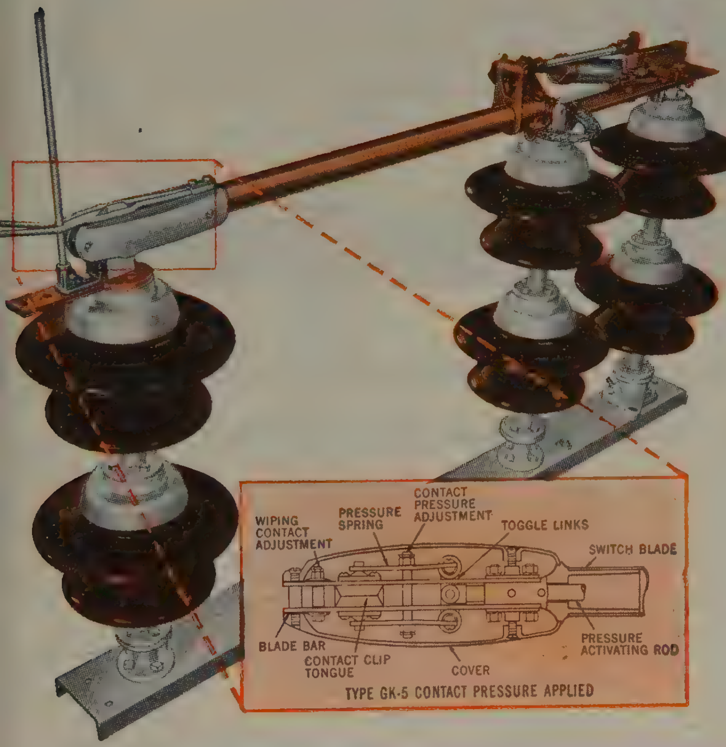
Side and Center Break 7.5 through 230 Kv.

Designed primarily for use on installations where phase spacing or operating room is limited.

- **EASILY OPERATED . . .** Insulator stacks, driven by crank and link mechanism, rotate in opposite directions to open the switch with a shearing action that easily breaks ice accumulations.
- **SILVER-INLAID, PROTECTED CONTACTS . . .** Non-ferrous housing provides corona shielding and sleet protection for contacts. Heavily silver-plated blade produces low resistance contact. Contact springs, out of current path, maintain positive pressure.

Type XX Center Break Switches range from 46 through 230 Kv. Type X Side Break Switches range from 7.5 through 115 Kv. Both range from 400 through 1200 amps.


TYPE XX



TYPE GK-5 CONTACT PRESSURE APPLIED

TYPE GK-5

For Sub-Station and Line Disconnect Service up to 287 Kv.

- **LARGE AREA CONTACTS** provide maximum thermal capacity.
- **SILVER CONTACT SURFACES** maintain lower contact resistance by preventing copper oxidation.
- **CONTACTS WIPE CLEAN WITHOUT ABRASION . . .** Blade and clip contacts engage with gentle wiping action that cleans surfaces without abrasion.
- **HIGH CONTACT PRESSURE APPLIED AFTER CLOSING . . .** High pressure is attained between blade and clip by the final movement of operating mechanism. This pressure is attained without abrasive movement between blade and clip contact surfaces. Contact pressure is released *before* blade moves in opening operation.

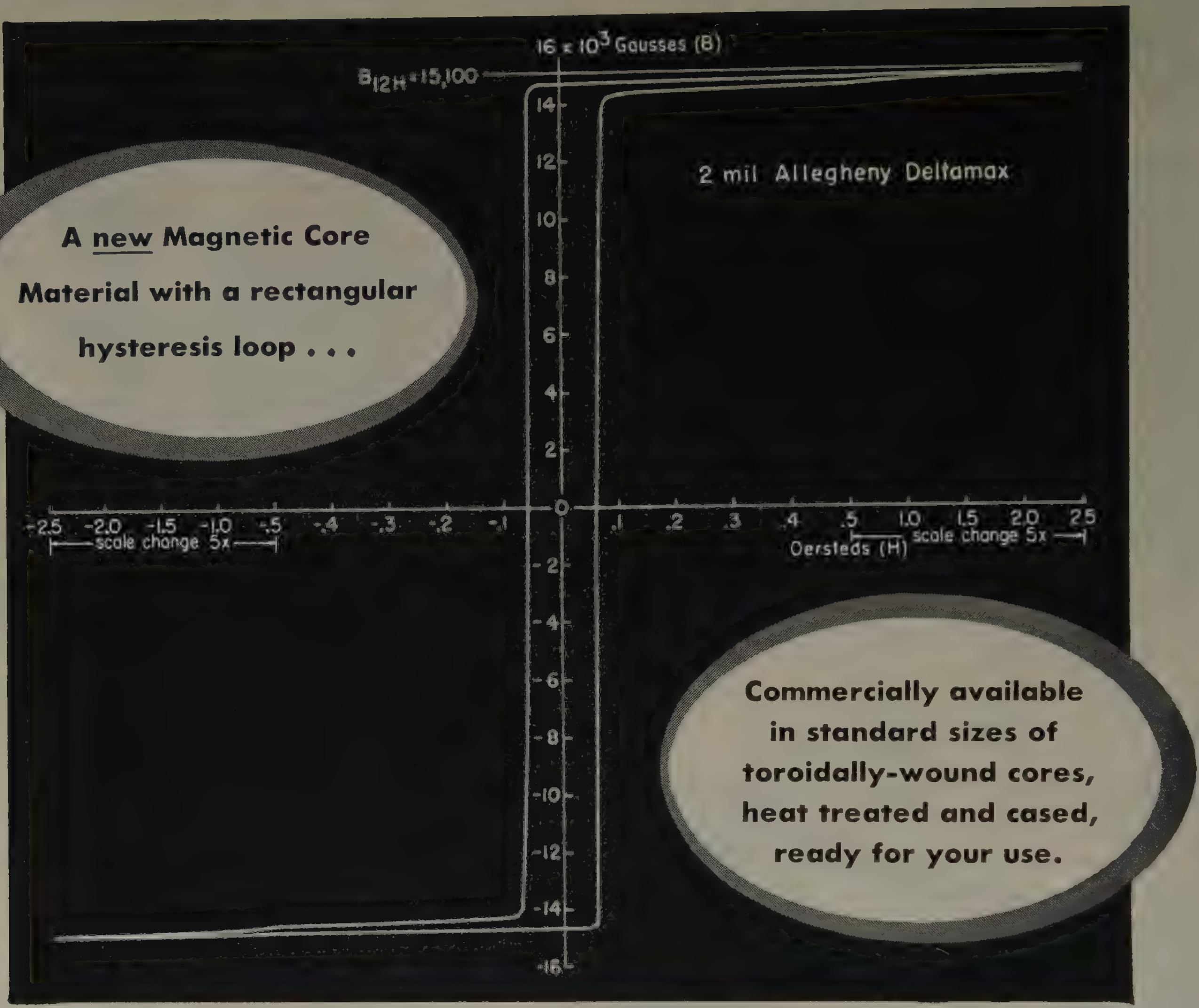
Diagram shows Type GK-5 contact mechanism. After closing motion is completed, cam-actuated control rod causes toggle links to expand against the leaf springs and transmit high pressure to the contact surfaces.

when you specify...

A·B·CHANCE CO·
ELECTRICAL TRANSMISSION & DISTRIBUTION EQUIPMENT
FOR CONSTRUCTION, MAINTENANCE & OPERATION

SAN FRANCISCO, CALIFORNIA

DELTAMAX-*now available!*



A new Magnetic Core Material with a rectangular hysteresis loop . . .

Commercially available in standard sizes of toroidally-wound cores, heat treated and cased, ready for your use.

Where can YOU use a Magnetic Material with these specialized, dependable characteristics?

The properties of Deltamax are invaluable for many electronic applications, such as new and improved types of mechanical rectifiers, magnetic amplifiers, saturable reactors, peaking transformers, etc. This new magnetic material is available now as "packaged" units (cased cores ready for winding and final assembly) distributed by the Arnold organization. Every step in manufacture has been fully developed; designers can rely on complete consistency in each standard size of core.

Deltamax is the most recent extension of the family of special, high-quality electrical materials produced by Allegheny Ludlum, steel-makers to the electrical industry. It is an orientated 50% nickel-iron alloy, characterized by a rectangular hysteresis loop with sharply defined knees, combining high saturation with low coercivity.

● *Call on us for technical data.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
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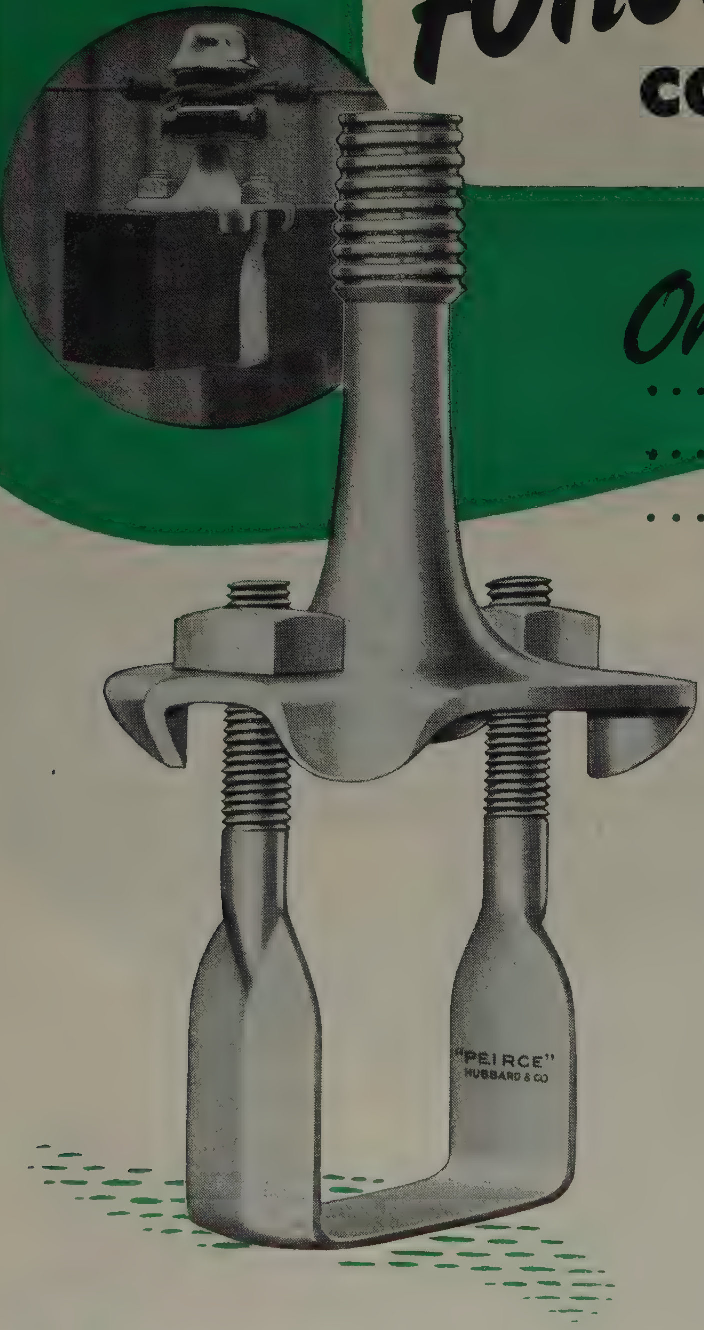
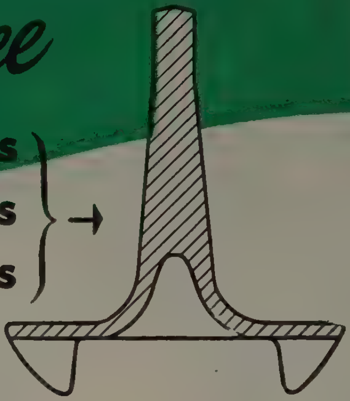
W&D 6379

HUBBARD *FORGED STEEL* CORNER PINS



One Piece

. . . no seams
. . . no joints
. . . no welds



Hubbard Drop Forged Corner Pins are made from a single piece of steel, forged to a broad base which completely covers the top of the arm. There are no seams, joints or pockets to retain moisture and hasten corrosion.

Due to the one piece construction, maximum strength is retained for the weight of metal used, and radio interference is minimized. Structural strength is also enhanced by the method of attachment, as the strap illustrated binds the wood fibres of the arm in such a way as to prevent splitting.

Hubbard and Company was the first to place this style pin on the market and it has been a popular choice for over twenty-two years. Furnished also with carriage bolts and a separate bottom strap to meet R.E.A. specifications.

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Dripping of compound at high temperatures: None.

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Flame Test: No burning of the paper indicator, nor any persistence of flame after last application of the test flame.

NOMINAL DIMENSIONS		
SIZE	NEOP. JACKETED	STD. BRAID
3#6	.47 x .74	.56 x .86
2#6 & 1#8	.45 x .73	.55 x .85
3#8	.38 x .62	.50 x .76

Note smaller diameter of this new cable compared to diameter of standard braid.

High Current Test: Cable did not flame, rupture, nor warp excessively.

Di-electric strength: No electrical breakdown as a result of this test.

Conductor Pull-Out tests: Using three different connectors, the U. S. Cable *held three times better* than standard design cables.

Rough Handling at Low Temperatures: A coil of the cable was exposed for 5 hours to a temperature of minus 34.4 C. It was then dropped 8 feet to a concrete floor. No breaks or cracks in the Neoprene sheath occurred.

Abrasion: The outer covering of the U. S. Cable proved to be over 10 times more abrasion-resistant than that of conventional design.

Write today for information to Electrical Wire and Cable Department, United States Rubber Company, 1230 Avenue of the Americas, New York 20, N. Y.

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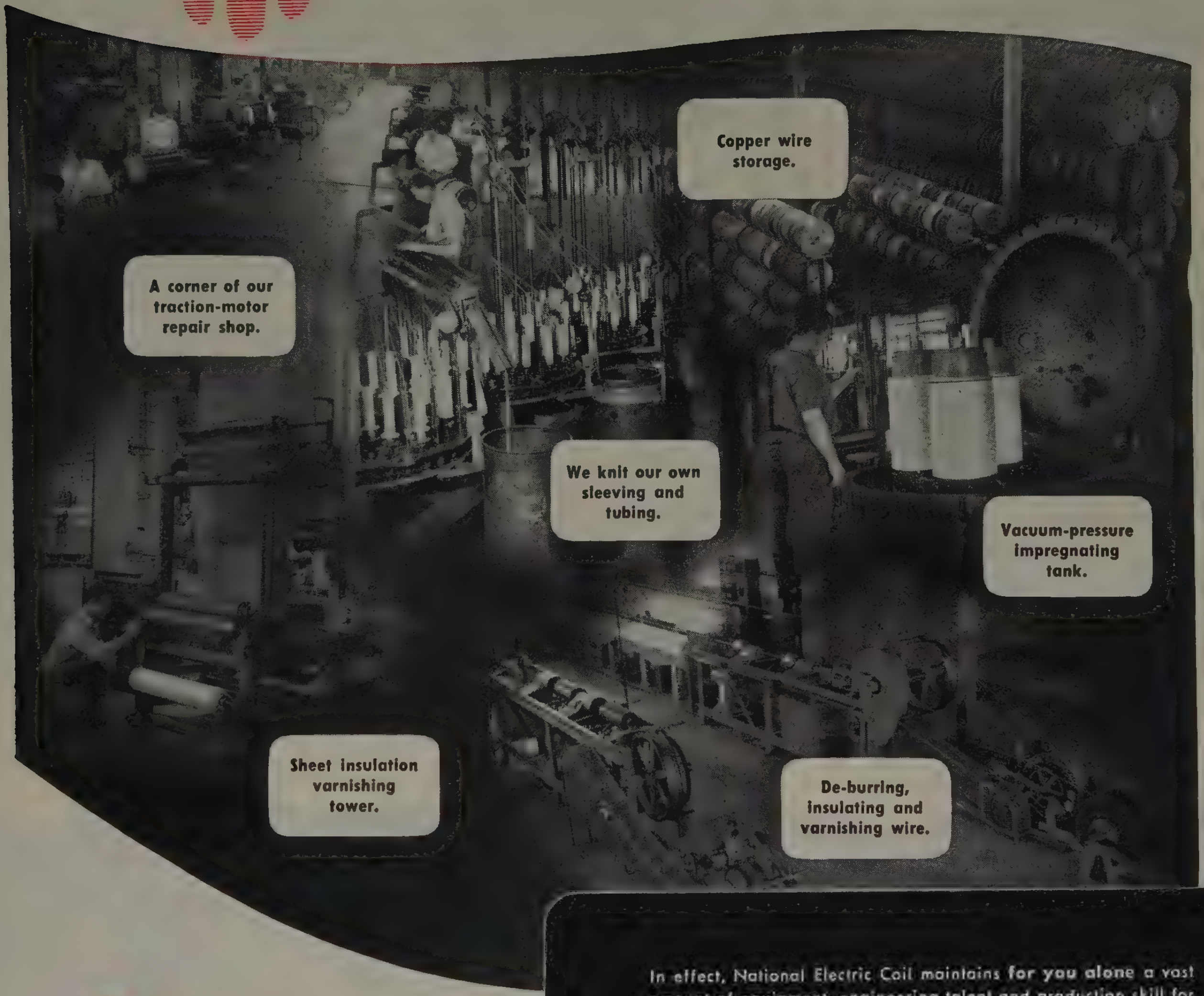
these motor-generator maintenance facilities *are yours!*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In effect, National Electric Coil maintains for you alone a vast amount of equipment, engineering talent and production skill for the repair or redesign of your rotating electrical machines. *It's maintained to give you the quick action and the skill you would expect if you could afford to have it in your own shop.* When motor or generator trouble crops up, let National handle it. If trouble persists, let National discover and overcome the cause. If needs change, let National redesign to meet the changed conditions. Use your National shop.

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NATIONAL ELECTRIC COIL COMPANY

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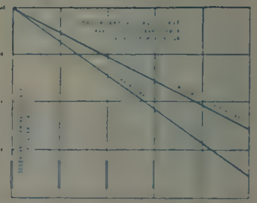
TRADE MARK

The inside story about MOLONEY HiperCore DISTRIBUTION TRANSFORMERS

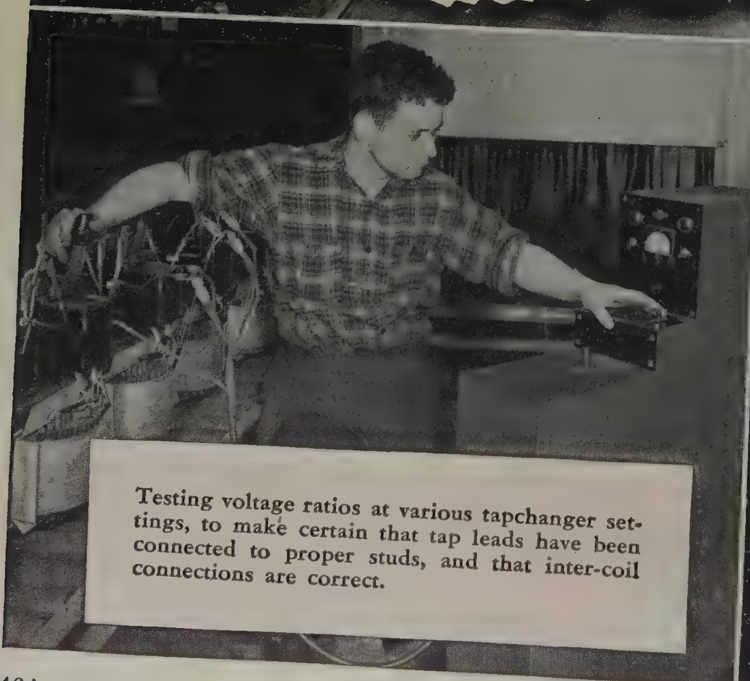
The inside story about Moloney HiperCore Transformers is centered around the material used in the cores. By using highly efficient oriented silicon steel it is possible to work the cores at higher flux densities than formerly. With the *total* flux requirements remaining practically unchanged, working the oriented steel at higher densities than practical with ordinary silicon steel, results in smaller cross-sectional areas of cores with a consequent reduction in weights.

The smaller cores permit the use of smaller windings, smaller tanks and less oil. This results in lighter weight and smaller transformers which are easier to install and handle generally, and take up less space on the poles. Reductions in size and weight have been made without sacrifice in all-around performance. In fact, HiperCore Transformer operating characteristics are better . . . voltage regulation has been improved . . . greater short-time overloads can be carried.



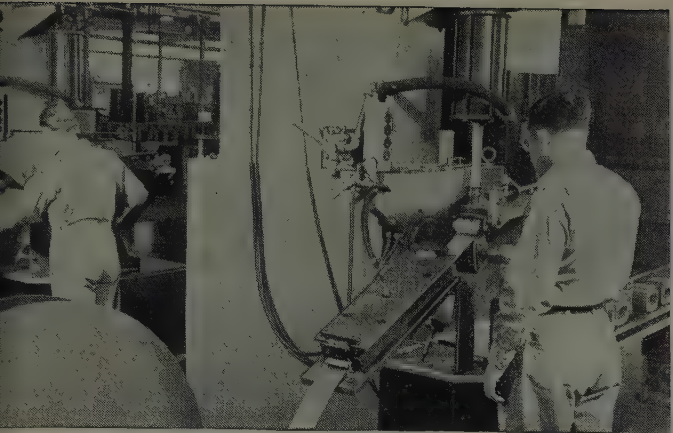
Illustrated are a few of the operations involved in the manufacture of HiperCore Transformers indicating the careful attention given to every detail in order to assure unexcelled on-the-job performance.

ME49-10

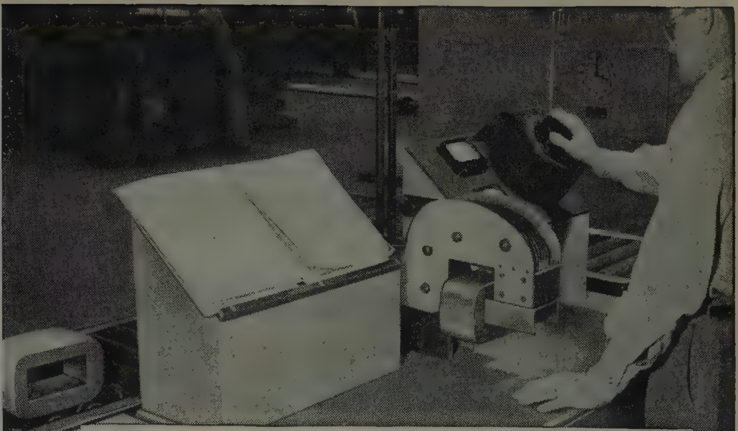


Testing voltage ratios at various tapchanger settings, to make certain that tap leads have been connected to proper studs, and that inter-coil connections are correct.

Placing core-and-coil assemblies in tanks after they have passed through oven which removes any moisture which may have been absorbed from the air, and also cures adhesive on core faces.



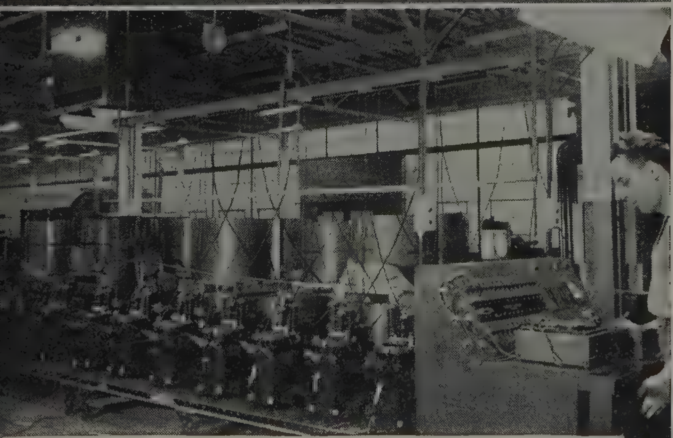
Cores are wound of oriented silicon steel. Winding machines are semi-automatic, stopping when proper thickness of winding is reached. End of core strip is spot welded.



Following winding of the cores, they are annealed in bell-type furnaces in a nitrogen atmosphere and are then given an initial test for losses as illustrated above.

Placing windings into position over U-shaped core pieces. Prior to this operation, cores have been impregnated, baked, cut, etched, and tested a second time.

Connecting tap leads from winding to tapchanger studs. On opposite side of assembly line, terminals are brazed to low voltage leads. Previous operations included applying adhesive to core faces, banding core pieces, and attaching frames.



After bushings have been installed, the tanks filled with oil, and the transformers vacuum treated to remove any entrapped air from the oil or windings, final electrical tests are made.

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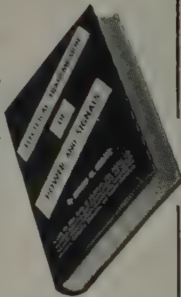

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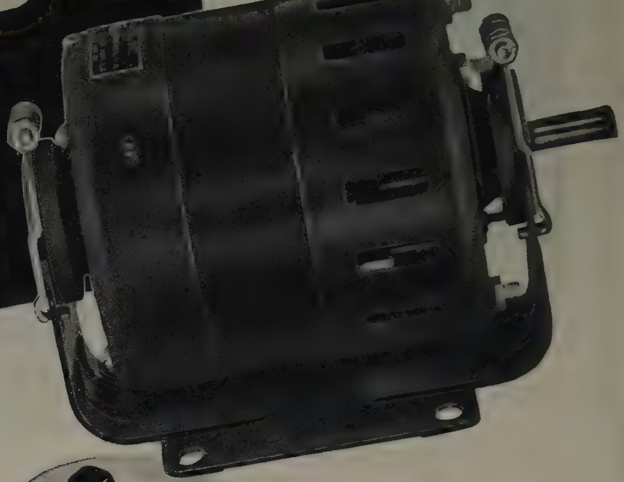

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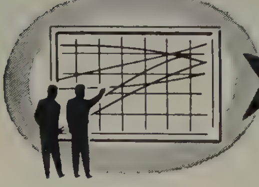

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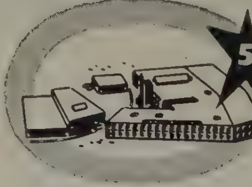

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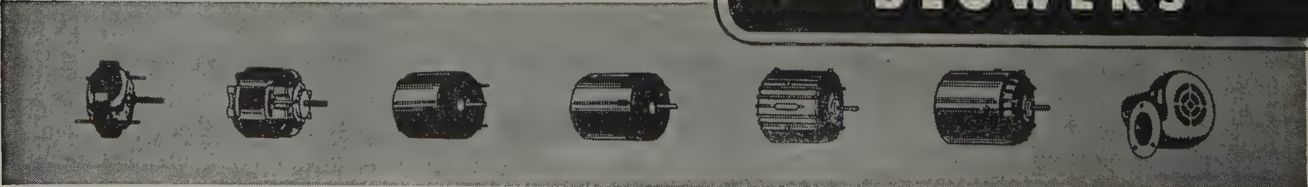
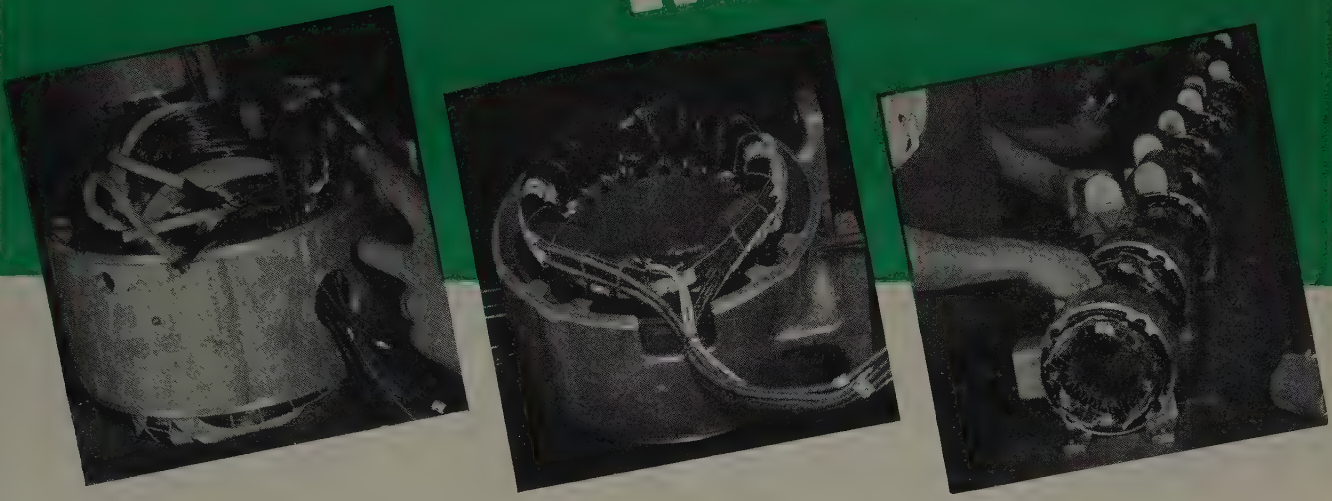


American MOTOR LEADS

are insulated and protected *with* NATVAR 400



The compact 1 HP single phase 115/230 volt, capacitor start—induction run motor, manufactured by American Electric Motors, Inc., Los Angeles, is especially recommended for use around dirt or dust-filled machines such as table saws or other woodworking tools. The centrifugal starting switch is totally enclosed, and the solid welded copper bar armature is mounted on high quality, standard size ball bearings lubricated for life. Leads are insulated and protected with Natvar 400.

American Electric Motors, Inc., Los Angeles, manufactures a line of induction motors, both single phase and polyphase, and a line of grinders and buffers. An excellent indication of their performance and value is the fact that they are widely distributed by a principal mail order chain.

Natvar 400 Extruded Vinyl Tubing is used on motor leads, because it is approved for 105°C continuous operating temperatures, it simplifies assembly, and gives better all around insulation and protection with considerable savings in labor and material costs and reduced waste.

Natvar 400, in addition to its ability to withstand heat, also has uniformly superior resistance to oil. It is available for prompt delivery either from a nearby wholesaler's stock or direct from our own. Full Underwriters' Laboratories report on request.

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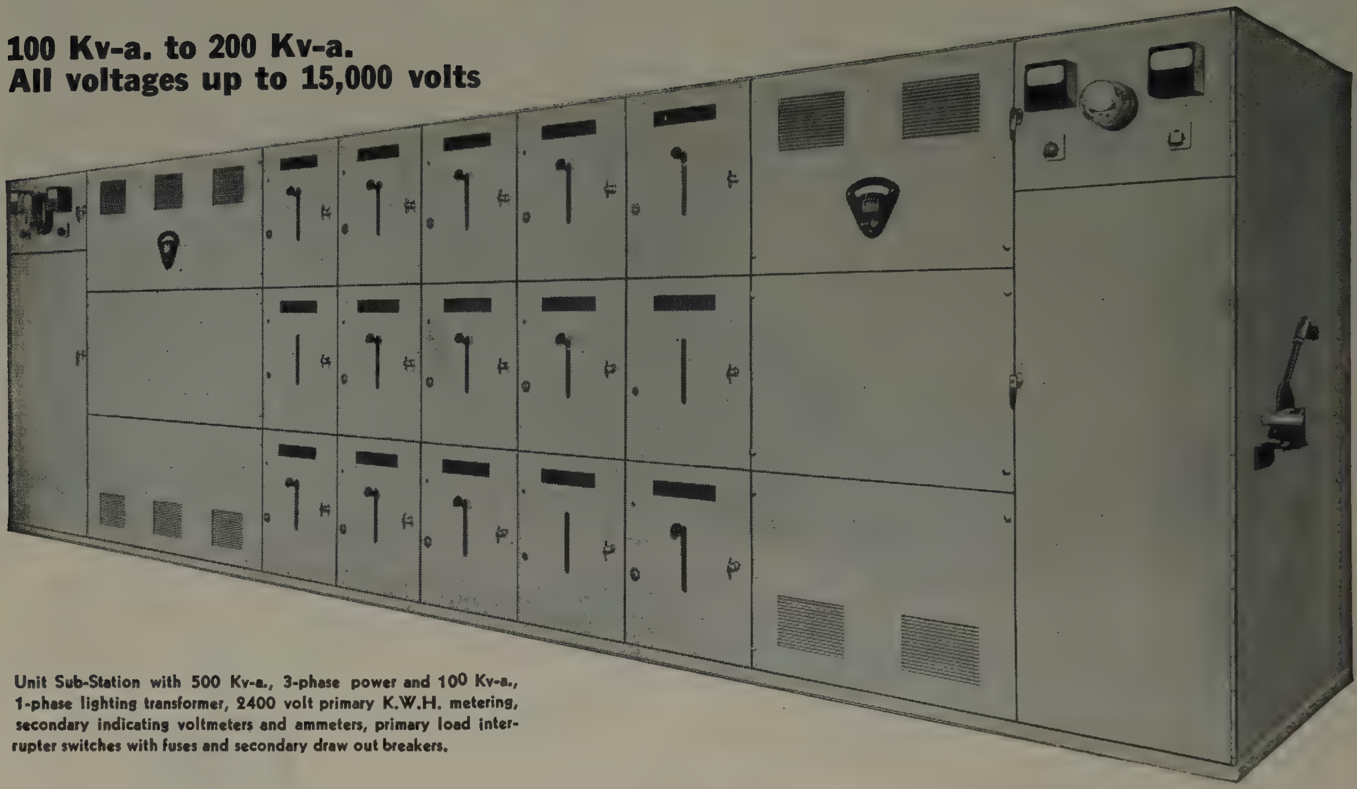

Unit Sub-Station with 500 Kv-a., 3-phase power and 100 Kv-a., 1-phase lighting transformer, 2400 volt primary K.W.H. metering, secondary indicating voltmeters and ammeters, primary load interrupter switches with fuses and secondary draw out breakers.

The complete unit sub-station is shipped in one or more factory-assembled units, completely wired, ready for installation and final connection. This eliminates the necessity for purchasing separately from various manufacturers the transformers, switches, fuses, insulators, circuit breakers and other accessories, and then assembling and connecting them on the job.

The entire sub-station, having all live parts enclosed, can be located in most any convenient place inside the building, without any other enclosure. Containing no oil, there is no need for a fireproof vault.

Maintenance expenses are reduced to a minimum, since there is no liquid to check, replenish or replace.

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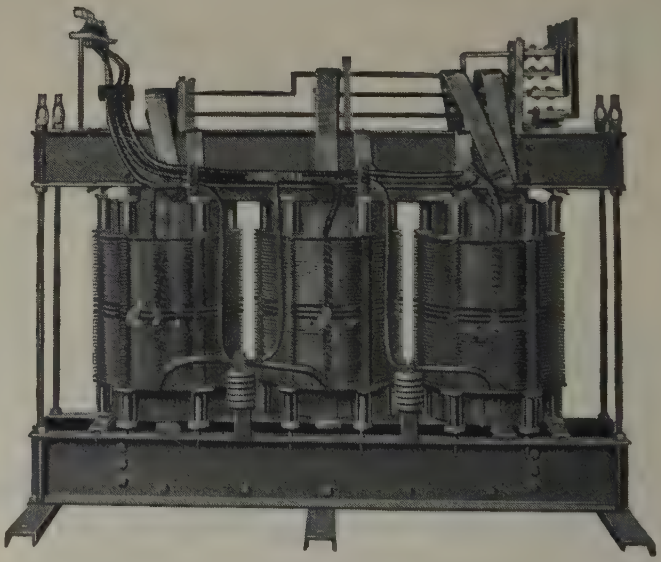
¼ Kv-a. to 2000 Kv-a. All voltages.



500 Kv-a., 3 phase, 13,800 volt Transformer with enclosure removed illustrates the disc type coil windings. This type of winding is employed for voltages above 5,000 volts. These disc type coils are separated from each other and supported with steatite ceramic insulators. All insulation is Class C and Class B throughout.

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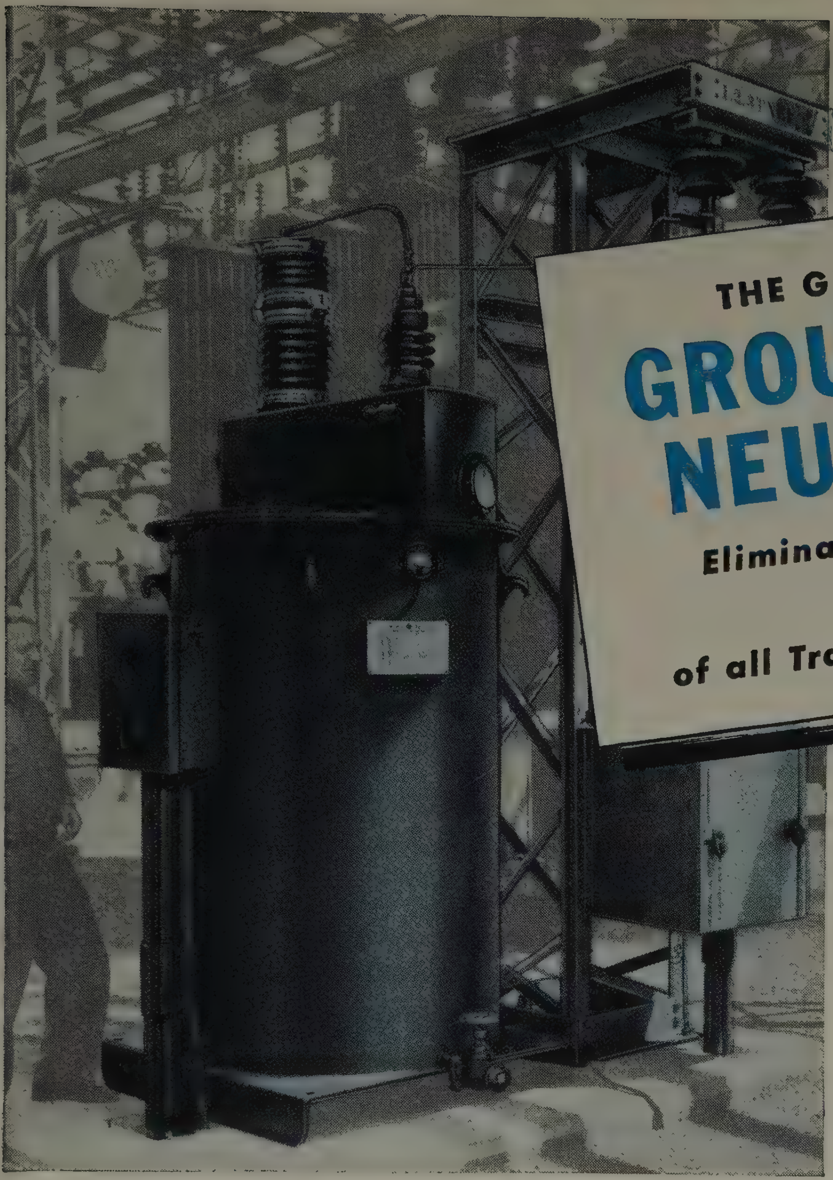

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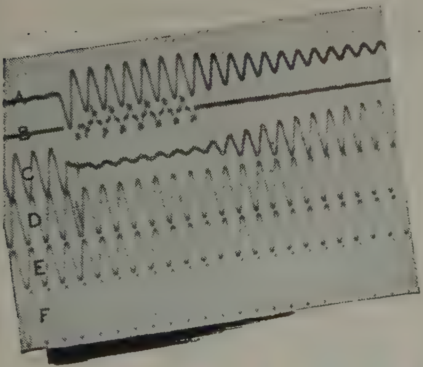
GROUND-FAULT NEUTRALIZER

Eliminates Tripping Breakers on 50 to 80% of all Transmission System Faults

The ground-fault neutralizer is basically an oil-immersed reactor, insulated for line-to-neutral voltage, which is connected between the neutral of a transformer and ground. Its inductive reactance is tuned, by means of a motor-driven tap-changing switch, to approximately equal the capacitive reactance of the system. In the case of a transitory line-to-ground fault, the current passed by the reactor neutralizes the system charging currents from the two unfaulted phases. Any remaining current is small and is practically in phase with the line-to-neutral voltage. Since current and voltage reach zero almost simultaneously, the arc is extinguished without restriking—without an outage, and without even a momentary disturbance of line-to-line voltage.



The effectiveness of the ground-fault neutralizer is well shown by this oscillogram taken during a transitory ground fault on a 69-kv system. It shows how the arc was quenched after a few cycles, without restriking; system line-to-line voltages were not noticeably disturbed. A = neutralizer current, 26 amp. B = fault current, 10 amp. C = line-to-neutral voltage of faulted phase. D, E, and F = line-to-line voltages.

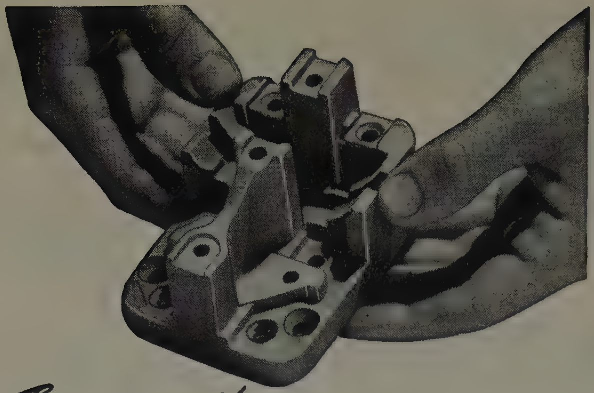
The General Electric ground-fault neutralizer is a protective device that quenches non-persistent line-to-ground faults in a few cycles and limits fault current to a few amperes. Thus, it prevents interruption of service during 50 to 80 per cent of all transmission system faults.

While this device has been well known in Europe for a great many years, it has only been recently that its many advantages have been widely recognized in this country. Compared to isolated-neutral systems, it eliminates high transient overvoltages that often result in flashovers at remote sections of the system. Compared to the solidly grounded system, it prevents service interruption; minimizes burning at the fault. Breaker operations are fewer, breaker maintenance is reduced.

In the belief that you will be interested in knowing more about the ground-fault neutralizer, we have revised our 16-page bulletin describing it. Ask your G-E sales representative for GEC-506, or write *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

611-59



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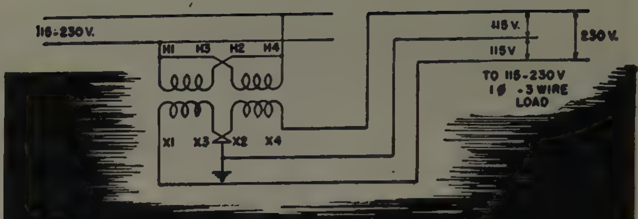

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Simply connect an Acme Electric 4 winding, insulated type transformer of the proper capacity to the 2-wire primary, make primary and secondary connections as indicated in diagram and you're all set for 3-wire 115/230 volt service.

Acme Electric, all steel, low temperature rise, air cooled transformers are made in capacities from 1/10 KVA to 50 KVA; standard voltages up to 600 volt primary. 2300 volt primary, capacities 1½ to 25 KVA. Write for Bulletin AC 160.

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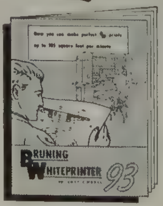

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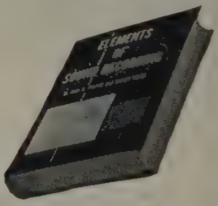

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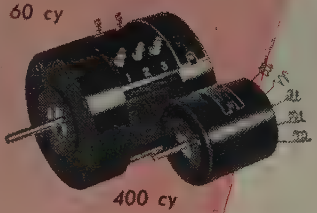

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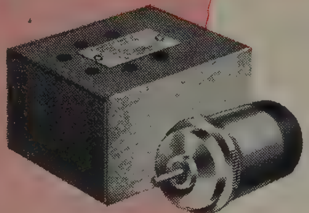

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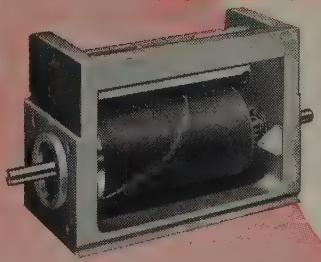

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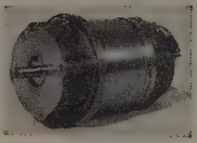

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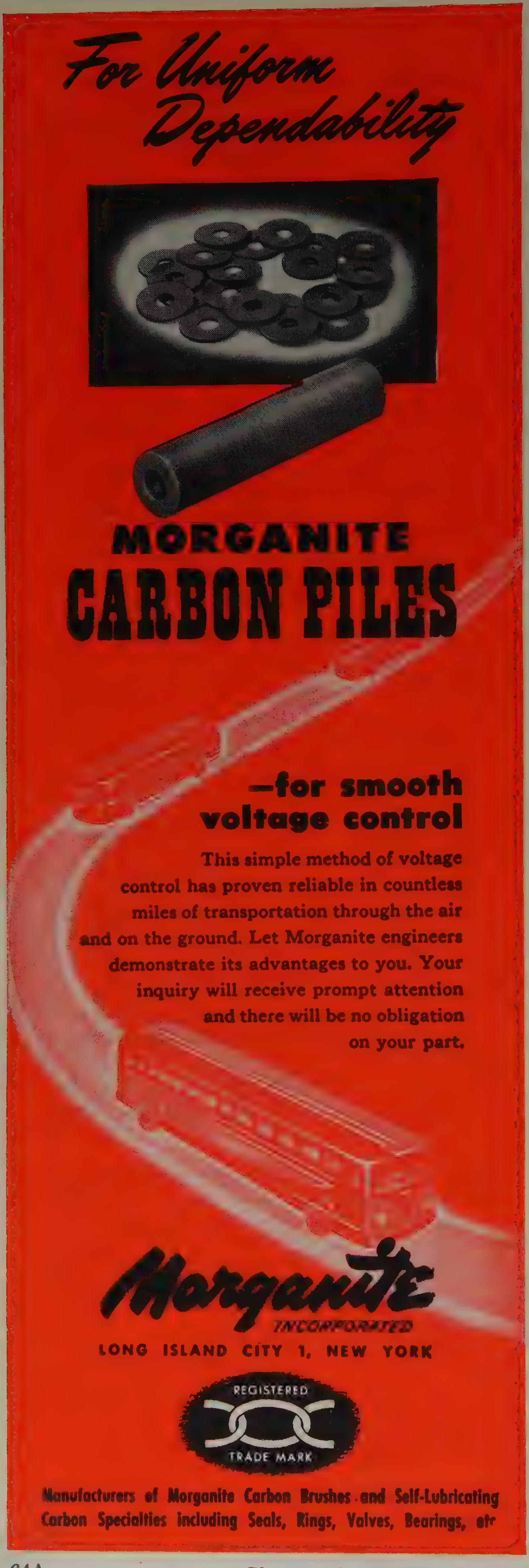

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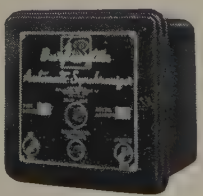

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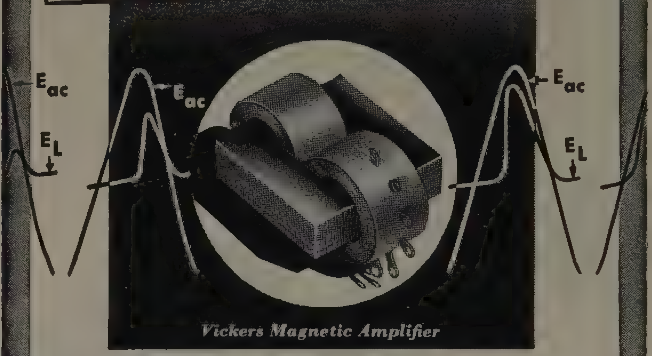

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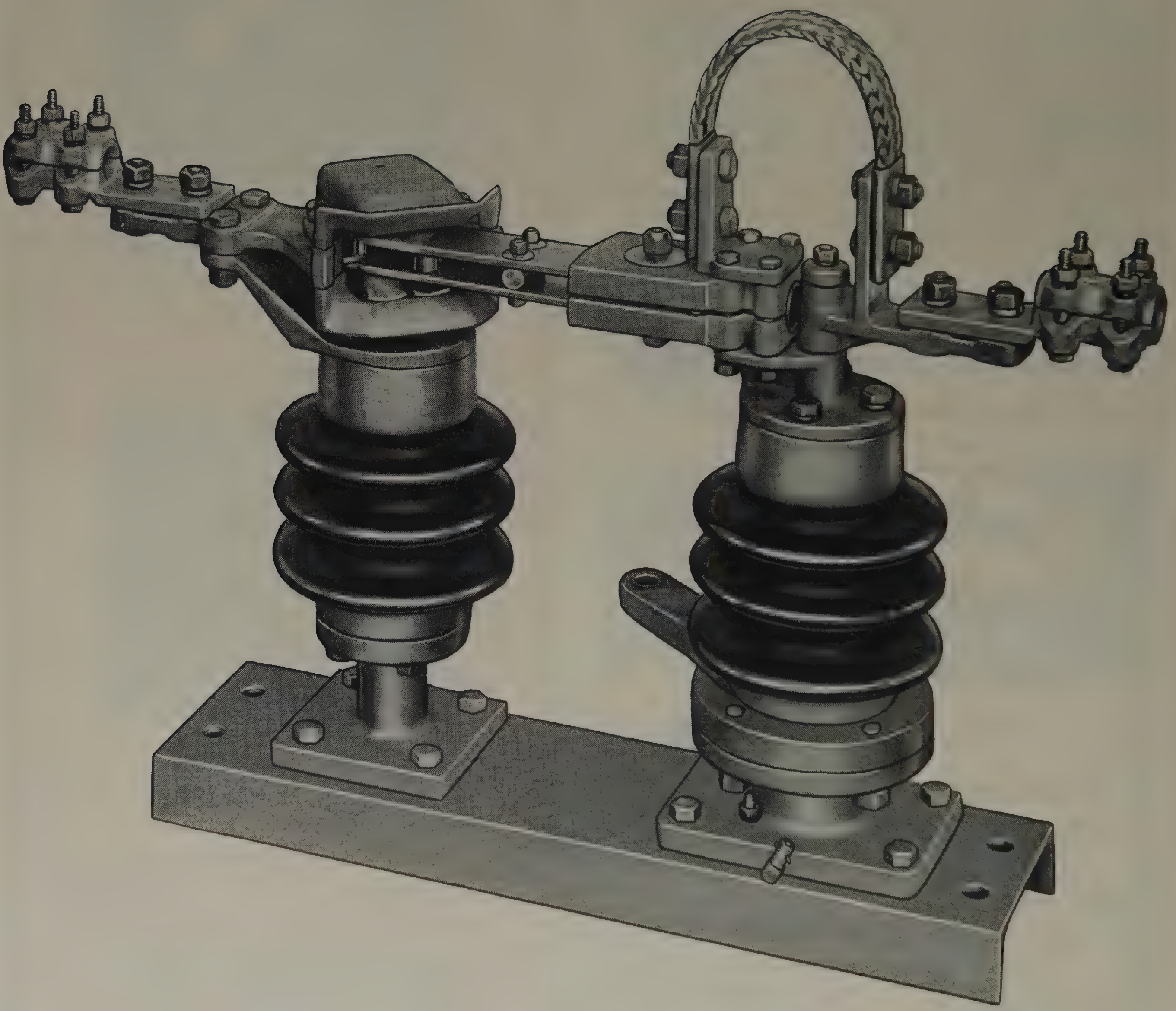

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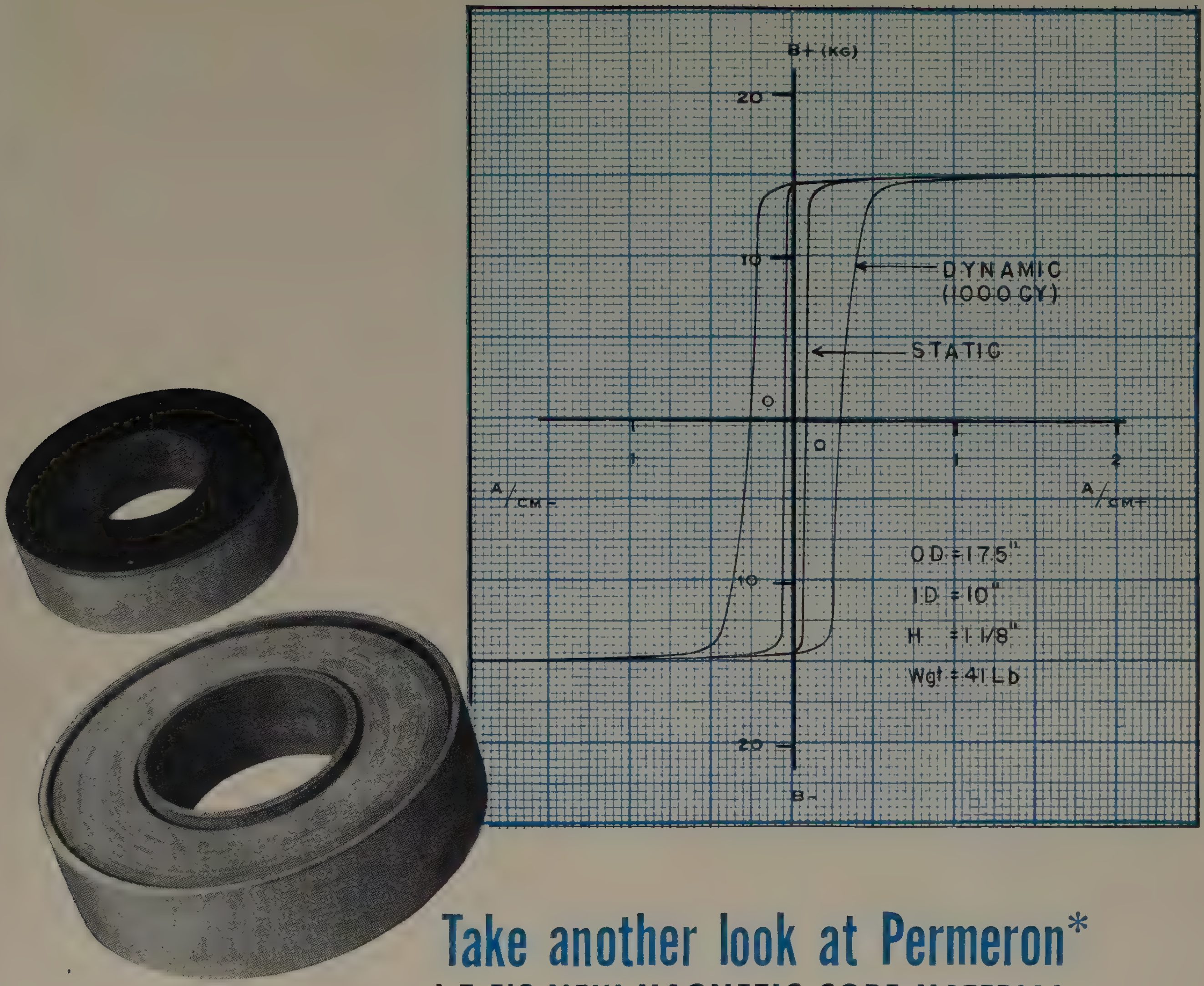

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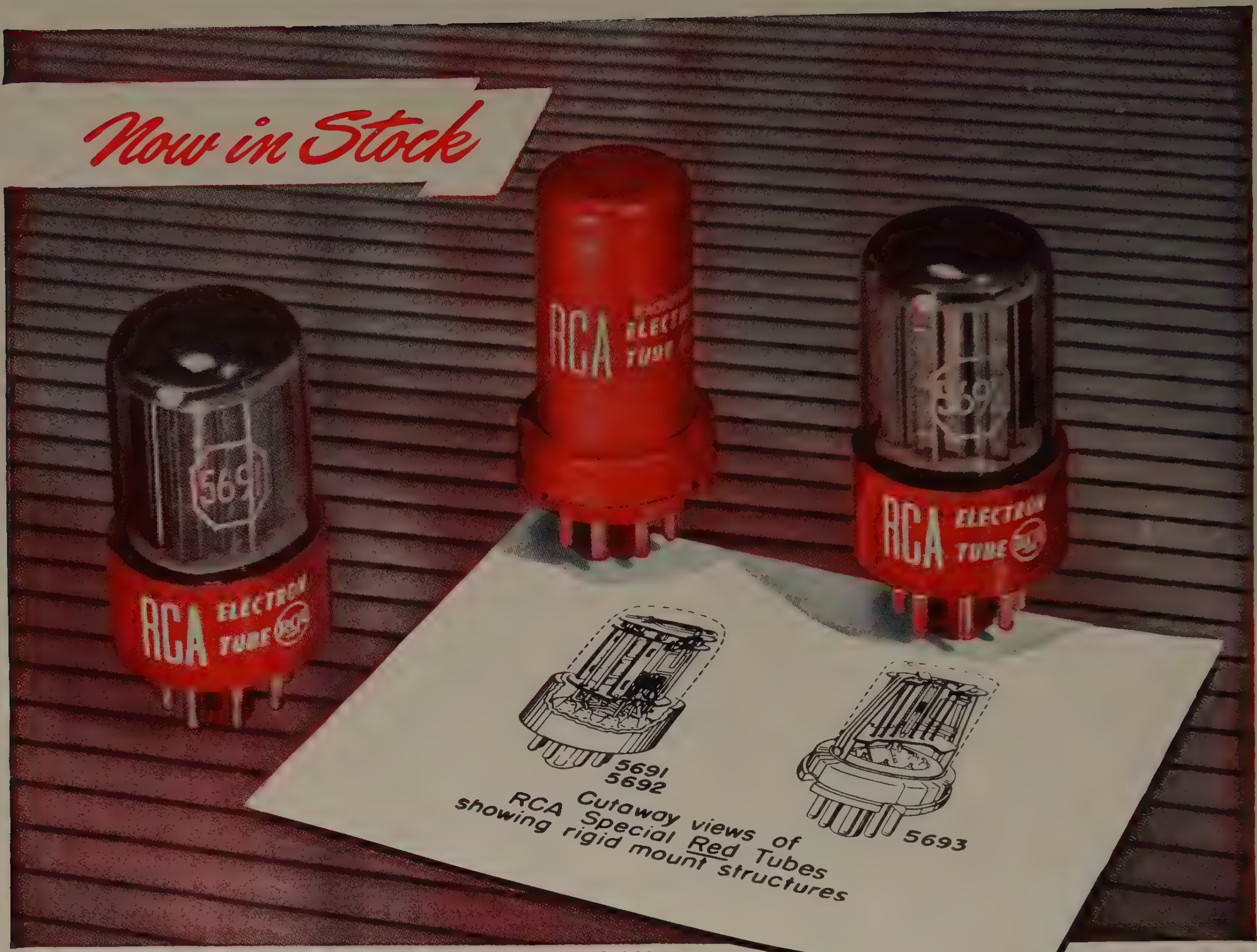

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HIGHLIGHTS........

1948 Index. The 1948 Index to *ELECTRICAL ENGINEERING* is being distributed with this issue as section II. It includes subject, author, AIEE and non-AIEE news, and biographical indexes.

Digests. The usual digests appear in this issue (*pages 10, 11, 15, 27, 28, 38, 39, 40, 41, 47, 57*).

Southern District Papers. Brief authors' digests report the essence of most of the District papers presented at the AIEE Southern District meeting in Birmingham, Ala., November 3–5, 1948. These papers will not be made available by AIEE in any other form (*pages 64–7*).

AIEE Special Publications. A list of recent AIEE special publications, together with their prices, is included in this issue. These publications are available from the AIEE Order Department, 33 West 39th Street, New York 18, N. Y. (*page 34A*).

1948 Developments. Each year brings new engineering developments that make for progress in the art, and 1948 was no exception. A picture survey reflecting some of these significant engineering developments appears herein (*pages 16–26*).

Ore Beneficiation. Ore beneficiation, in its broadest sense, is the treatment of ores to improve their quality. An introduction to this topic is presented for the general information of electrical engineers, who, as a group, have contributed substantially to its progress (*page 48*). With the development of large iron ore beneficiation plants, new problems of power generation and distribution are introduced. The importance of the subject is evident when it is considered that 60–75 kilowatt-hours will be required to produce one ton of concentrate from the low-grade taconite ore that will have to be utilized to maintain present steel production from domestic sources (*pages 49–56*).

Electronics and Engineering Education. It can be said of electrical engineering education that great depth has been achieved, but in so doing the field has been limited severely. The impact of electronics will be to create a strong urge toward achieving breadth, an urge which must be answered without sacrificing the strength gained in depth (*pages 58–61*).

Railroad Radio. By the use of railroad radio the work of train crews is facilitated, safety is enchanced by eliminating unnecessary stops, the work of the crew members is better co-ordinated, time is saved both en route and entering and leaving terminals. There are many known instances of such increased efficiency and safety, and railroads soon should have sufficient data from which to show accurately the savings that can be made by its general use (*pages 1–7*).

Careers in Utilities. When the electrical engineering graduate chooses his field, he wants to see possibilities for advancement with speed measured by personal abilities. He wants to be in an industry which promises continued growth, with new frontiers for development. He hopes for personal security along with personal prestige and satisfaction. Contrary to a prevalent impression, all of these factors are to be found in the electrical utility field for "electrical utilities are engineering businesses and they offer good opportunities for engineering careers" (*pages 7–9*).

The Arc in "Heliarc" Welding. In the process of Heliarc welding, the arc is drawn between the workpiece and a virtually nonconsumable tungsten electrode while the electrode, the arc, and the weld metal are protected by a sheath of inert gas. However, the electric arc in an atmosphere of inert gas has two particular properties that differ decidedly from those encountered in the metal arc-welding process. This article shows how they affect the application of arc welding (*pages 30–3*).

Operational Calculus. As commonly used, the term "operational calculus" implies those different methods of obtaining a solution of a set of differential equations whereby satisfaction of the specified boundary conditions is incorporated automatically in the course of solution. Three methods are now in general use: The Heaviside operational calculus, Jeffreys' operational method, and that utilizing Laplace transform theory (*pages 42–5*).

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Electric-Potential Notation. By showing, in this article, how the same confusion that is present in electric-potential notation conventions could have arisen in electric-current notation, "it is not being suggested that confusion is desirable in current notation also, just for the sake of uniformity; but rather that, since current notation could be confusing but is not, uniformity may be gained by putting the potential case in the form which is the dual of the prevalent current case" (*pages 62–3*).

Magnetic Amplifiers. The many desirable features of magnetic amplifiers are attracting wide industrial interest. Ruggedness, long and service-free life, a-c operation, high power gain possibilities (power gains as high as 1,000,000 to 1 are possible), as well as instantaneous operation are desirable characteristics that make these devices specially adaptable for naval shipboard applications (*pages 33–7*).

Dummy Loads for Welders. "A dummy load switched by electronic control can be used successfully to limit voltage variation resulting from the operation of seam welders or other similar loads of known fixed quantity and power factor" (*pages 12–14*).

Personal Item. In amplification of the personal item reporting the appointment of Abe M. Zarem as chairman of physics research and manager of the new Los Angeles (Calif.) division of the Stanford Research Institute (*EE, Oct '48, p 1015*) it should be noted that following his graduation from the Armour Institute of Technology in 1939, Doctor Zarem did graduate work in electrical engineering at the California Institute of Technology in Pasadena, receiving his master of science degree in 1940, and his doctorate degree in 1944.

Corrections. The following author's corrections in the article, "Electrical Prerotation of Landing Gear Wheels," J. H. Keyser Jr., (*EE, Dec '48, pp 1154–9*) were received after the issue had gone to press. Page 1156, column 2, line 3 under Figure 6: should read "speed will be 85 ± 10 miles per hour," not "85×10 miles per hour." Page 1157, column 1, second equation: should read "$T = 2\pi IN/60t$" not "$T = 2S\pi/60t$." Page 1158, column 1, paragraph 2, fifth line: should read "throughout the permissible speed range" not "permissible range speed." Page 1159, column 1 of the appendix: minus signs should be inserted preceding the logs of the equations to be found on the fifth and seventh lines from the bottom of the column. Page 1159, column 2 of the appendix, first equation: should read "$-\log_e(N_m - N) + \log_e N_m = (60T_m/2\pi IN_m)t$."

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices, 500 Fifth Avenue, New York 18, N. Y. Subscriptions $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50 Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. January 1949, Vol. 68, No. 1. Number of copies of this issue 50,500

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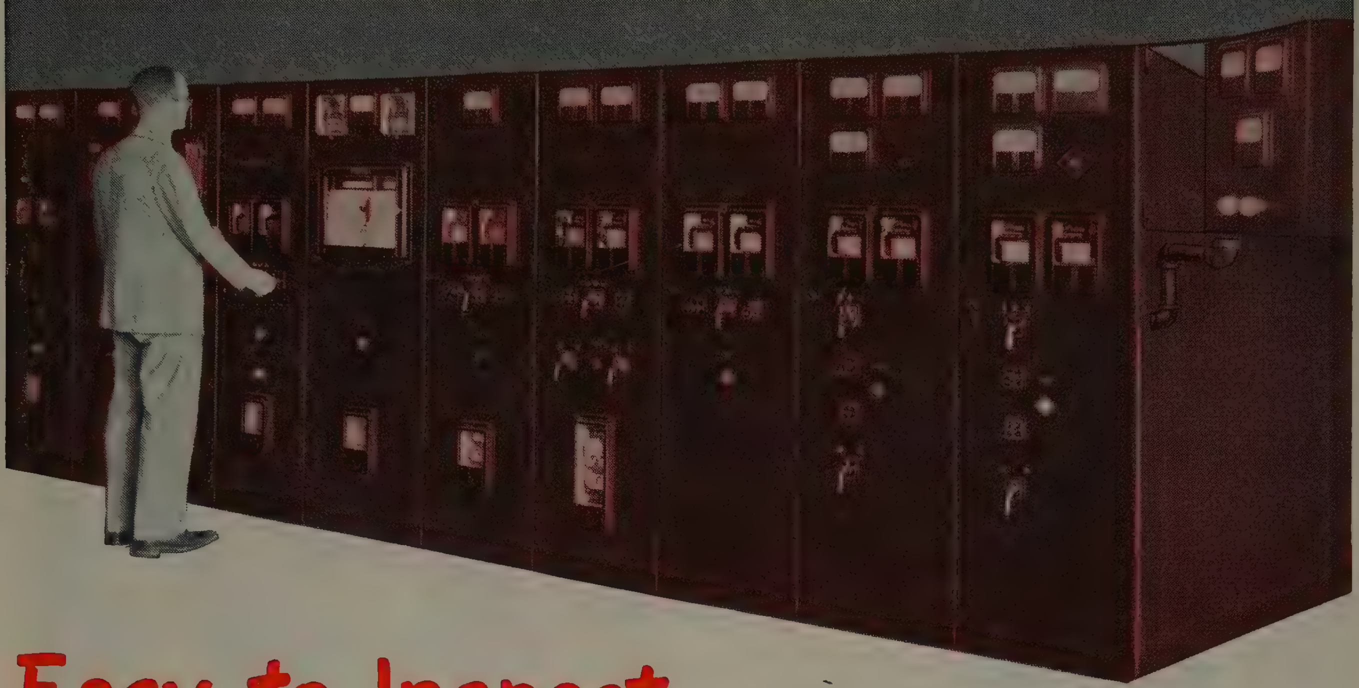

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INDUSTRIAL NOTES ....

Westinghouse Appointments. Harry E. Seim has been appointed general manager of the Sturtevant division of the Westinghouse Electric Corporation, and Tom Turner takes on the responsibility of general manager of the Elevator division at the Jersey City, N. J., plant. Both men will retain their former posts in addition to assuming their new duties. Seim and Turner are replacing Ellis L. Spray, vice-president in charge of the Elevator and Sturtevant divisions.

New President and Director for Teletype. Timothy E. Shea, assistant engineer of manufacture of the Western Electric Company, has been elected president and a director of the Teletype Corporation, a subsidiary of the Western Electric. Mr. Shea succeeds the late Clem H. Franks. Mr. Shea has been with Western engineering department and the Bell Telephone Laboratories for the past 28 years.

M. P. Painter G. E. Brockport Plant Manager. The newly-acquired plant of the General Electric Company at Brockport, N. Y., has for its manager Montell Parker Painter who joined the company in Erie, Pa., in 1932 as an apprentice toolmaker. He subsequently became general foreman of the turbine division, and later held a similar position in the home freezer division.

Finlay Opens Own Offices. Robert Finlay, wartime procurement engineering counsel for the Hallicrafters Company in Washington, D. C., has opened his own offices at Ridgewood, N. J., to serve as liaison consultant between electronics manufacture and government agencies.

Hagan Appointment. M. J. Boho has been elected vice-president in charge of sales of Hagan Corporation. Mr. Hagan joined the company in 1936 as a field service engineer.

Callahan Heads G. E. Cathode-Ray Tube Engineering. As division engineer of cathode-ray tube in General Electric Tube division, Mr. Callahan will head up all design and application engineering and standardizing activities relating to cathode-ray tube product lines.

Westinghouse Lamp Division Staff Addition. Marshall N. Waterman, former member of the executive staff of the Electrical Testing Laboratories, Inc., has joined the Westinghouse Lamp Division as staff assistant to Ralph R. Brady, commercial engineering manager.

J. A. Nary Joins United States Testing Company. As vice-president in charge of production, James A. Nary has become associated with the United States Testing Laboratories, Inc. He will make his headquarters in Hoboken. In addition to his work of co-ordinating the activities of the various divisions of the company, he will also supervise the company branch laboratories in New York, Boston, Chicago, Woonsocket, Philadelphia and Los Angeles.

TRADE LITERATURE

Allis-Chalmers Substation Transformers Bulletin. Construction details and performance features of Allis-Chalmers substation transformers for rural and industrial service in ratings from 50 to 500 kva are covered in a new eight-page bulletin. It also includes a description of core and coil construction of the units, tank design and construction, and a dimension table for the 50 to 500 kva, single phase, 60 cycle, 50 degree rise transformers in classes ranging from 24,000 to 66,000 volts. Copies of this bulletin, No. 61B6014A, are obtainable upon request from Allis Chalmers Manufacturing Company, S. 70th Street, Milwaukee, Wis.

Allied Radio 1949 Catalog. 180 pages. Everything in Radio and Electronics, the 1949 catalog of the Allied Radio Corporation places special emphasis on equipment for industrial maintenance, research, and production requirements, as well as for the needs of government agencies. There are detailed listings of electronic tubes, test instruments, transformers, resistors condensers, rheostats, relays, switches, rectifiers, tools, wire and cable, batteries, sockets, generators, power supplies, and other types of equipment in the industrial field. This new catalog may be obtained from Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Ill.

New Jersey Zinc Pamphlet. Applications and Properties of Nonferrous Powder Parts is a six-page pamphlet, illustrated, dealing with some of the technical aspects of nonferrous powders and specific case histories. These case histories feature the savings resulting from the use of pressed powder parts. The pamphlet may be had by writing to The New Jersey Zinc Company, 160 Front Street, New York 7, N. Y.

Cannon Electric Battery Connector Bulletin. 24 pages. The third edition Battery Connector Bulletin, No. GB-648, contains photos, dimensional drawings, exploded views, application pictures and technical data on battery connector line used largely on aircraft batteries, aircraft starting equipment, oilfield equipment, and stationary engine starting equipment, and general industrial starting equipment. To secure a copy of the GB-648 Bulletin write to Cannon Electric Development

(*Continued on page 20A*)

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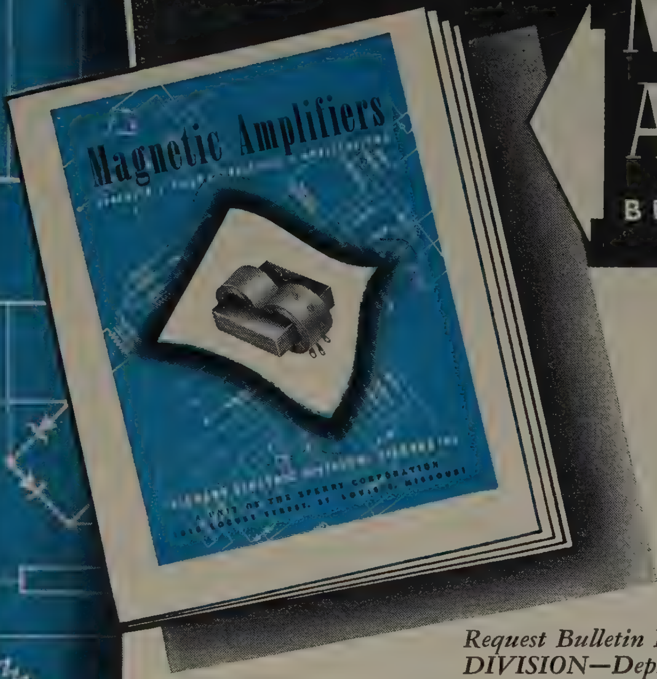

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VICKERS ELECTRIC DIVISION

VICKERS Inc.

1815 LOCUST STREET • ST. LOUIS 3, MISSOURI

A UNIT OF THE SPERRY CORPORATION

(*Continued from page 16A*)

Company, 3209 Humboldt Street, Los Angeles 31, Calif.

Power Factor and What to Do About It. New 20-page pocket-size booklet No. 200-TEC-1077 of Electric Machinery Manufacturing Company, explains the essentials of power factor in industrial plants and gives a digest of power-factor calculation, why low power factor should be corrected and how it can be done. Electric Machinery Manufacturing Company, Minneapolis 13, Minn., will send copy upon request.

Rivnut Data Book. A revised edition of The B. F. Goodrich Company data book on blind fasteners is a 28-page pocket-size booklet containing information on Rivnut types, the selection of the proper Rivnut, the drilling of the hole, the use of splined Rivnut, and information on various Rivnut tools. Interesting parts of the new book are announcements of new power and manual tools for use with Rivnuts. Send for your booklet to The B. F. Goodrich Company, Akron, Ohio.

Selection of Electric Plants. Catalog by D. W. Onan & Sons Inc., 20 pages, contains a model guide to assist in the right selection of electric plants. This guide points out the difference between a-c, d-c, and battery-charging models and gives instructions for choosing the proper type, size, and starting method. A general information section gives statistics on watts required by electric appliances and motors, helpful data on refrigerators, deep freezers, oil burners, washing machines, and water systems. The catalog also describes Onan electric plants in sizes ranging from the portable model AAE, 350 watts and weighing 77 pounds, to the 35,000-watt Diesel units. When writing for your copy to D. W. Onan & Sons Inc., Minneapolis, Minn., mention Onan Electric Plant Catalog, Form A-138A.

Metal Joinings. Eight-page bulletin. This illustrated bulletin of Eutectic Welding Alloys Corporation describes how eutectic low temperature welding alloys compare with welding and brazing processes. This issue of The Eutectic Welder explains how 15 of the eutectic alloys can save defective equipment and machinery and how the low heat welding is used to best advantage in construction work and fabrication. Another feature is the new cutting electrode, Cuttrode, that makes easy the cutting of metals without the use of special equipment or oxygen. Detailed instructions for use of each welding alloy are also given. This bulletin may be obtained by writing to Eutectic Welding Alloys Corporation, 40 Worth Street, New York 13, N. Y.

Motor and Gear Box Circular. Bulletin No. 10-10 of the Janette Manufacturing Company describes the Janette gearmotors and speed reducers. For booklet and further information send to Janette Manufacturing Company, Chicago, Ill.

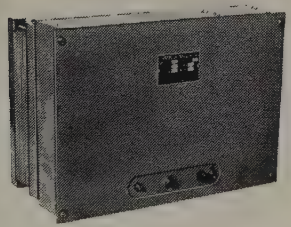
Five-Way Binding Post Pamphlet. The Superior Electric Company has issued its new 5-Way Binding Post pamphlet which outlines the five uses to which the binding posts are adaptable: permanent clamping, spade-lug connection, plug-in for banana plugs, looping and clamping, and clip lead. Electric equipment is illustrated as examples of the binding posts' uses. This pamphlet is available from The Superior Electric Company, 422 Hannon Ave., Bristol, Conn.

Fractional Horsepower Motor Brushes. The 44-page Fractional Horsepower Equipment Brush User's Guide by the Stackpole Carbon Company contains data for selecting and applying brushes for longer life and better performance on a wide variety of small-motor equipment and under varied conditions of use. Particular attention is paid to brush problems and their remedies for universal motors, automotive generators, automotive starters, aviation generators, single phase motors, and other types. The guide also describes the Stackpole silver graphite types. Also included are data on shunts and shunt connections, caps, terminals and hammer plates. A copy of the catalog will be sent upon request by writing directly to the Stackpole Carbon Company, St. Marys, Pa.

General Cement Catalogue. 64 pages. This catalogue contains complete information

(*Continued on page 32A*)

the first line of standard



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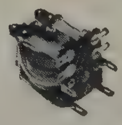

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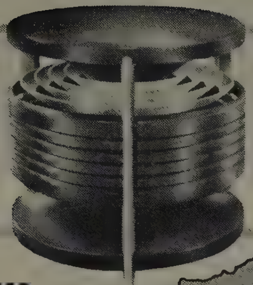

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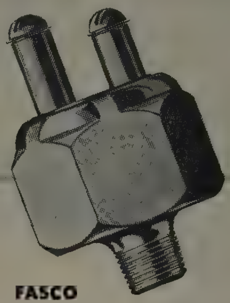

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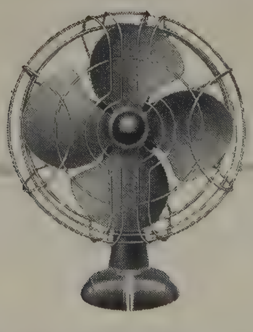

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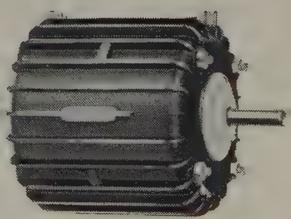

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Yours for the asking!

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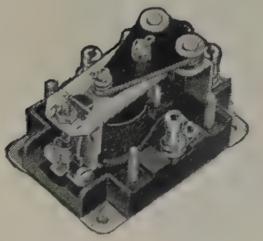

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This bulletin makes it easy for you to select small industrial control relays with the exact contact arrangement, mounting details and construction required for each application. In concise, easily understood form, it contains complete information on standard Struthers-Dunn Midgets and includes many available adaptations to fit these to specific operating conditions. Ask for Data Section 2100.

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(*Continued from page 20A*)

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Supersonic Reflectoscope. Operation and application of the new portable, lightweight Type SR05 Supersonic Reflectoscope is described in Bulletin No. 3001 of Sperry Products, Inc. This illustrated pamphlet outlines the principle of operation, advantages to user, the materials that may be tested and so forth. Copies may be obtained by writing to Sperry Products, Inc., 1505 Willow Avenue, Hoboken, N. J. Position-Adjusting Control.

NEW PRODUCTS • •

Projection Welder. The projection welder, designated as type *PT-0*, by Acme Electric Welder Company, 2618 Fruitland Road, Los Angeles 11, Calif., is an air-operated press-type, direct-action machine,

(*Continued on page 37A*)

The most difficult Insulating problems are solved with

SINCE 1919 MYCALEX THE INSULATOR
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LOW LOSS HIGH FREQUENCY INSULATION TO MEET HIGH MECHANICAL AND ELECTRICAL SPECIFICATIONS WITH OR WITHOUT METAL INSERTS

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CLIFTON, N. J.

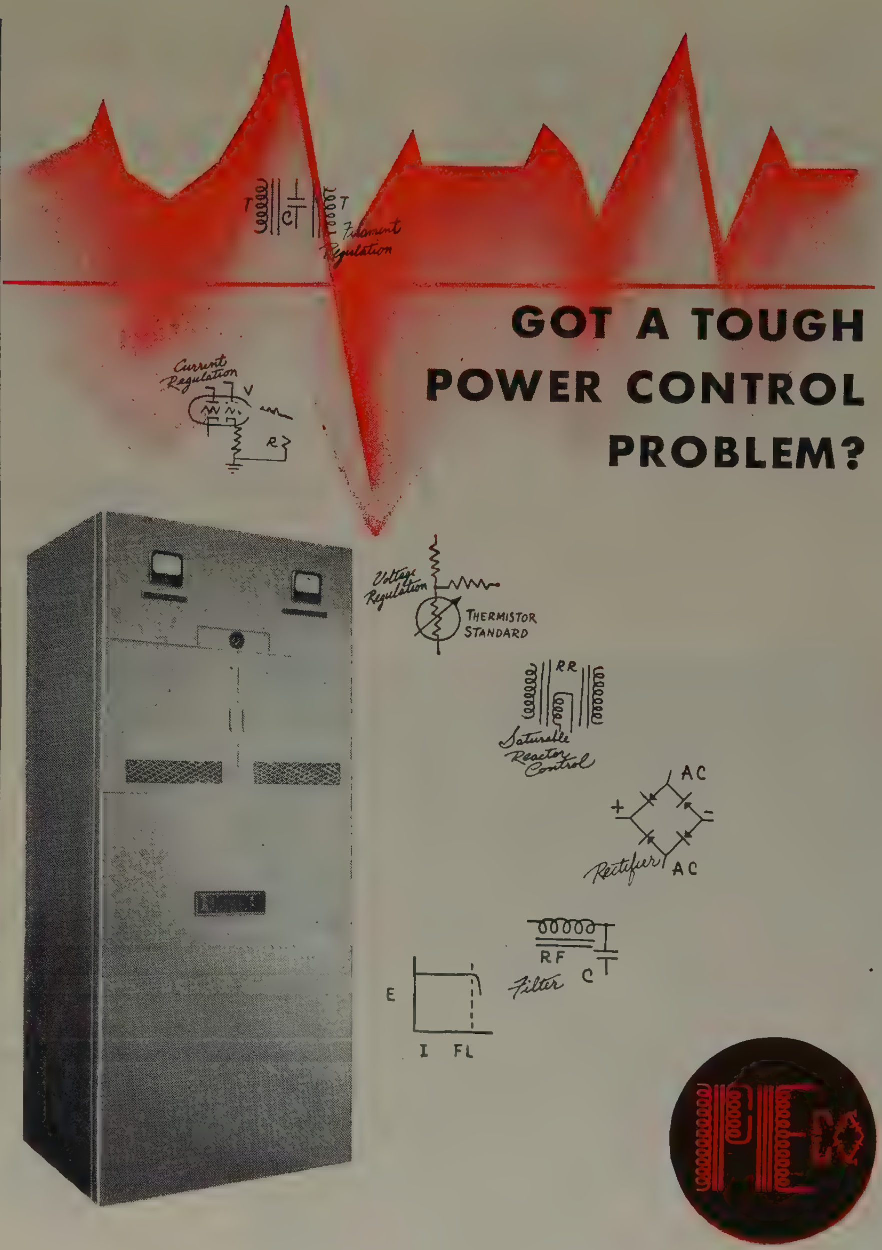
(Continued from page 32A)

in either 20, 30, or 40 kva. Horn adapters and horns to convert for conventional spotwelder use are available. The machine was developed especially for manufacturers having light welding jobs, where speed is desirable. A solenoid-operated air valve with either a single-stage or 2-stage foot switch is furnished on the *PT-0*. Standard throat length is six inches; when converted to a spot welder the machine's throat length is increased an additional six inches.

Coil Winding Machine. New improvements in a coil winding machine that permits almost micrometer adjustment of travel of guide rollers through positive electric limit switches, and easy positive adjustment of guide rollers in relation to the coil or arbor, have been announced by Associated Production Company, 2655 W. 19th Street, Chicago 8, Ill. This machine winds coils of all types in 16-gauge to 42-gauge wire. Coils up to 10-inch outside diameter.

Plug-In Strip. A solid continuous copper-conductor system and a simplified installation without disassembly are features of the new plug-in strip marketed by National Electric Products Corporation. The strip is available in two lengths and two spacings of receptacles. Ten matching fittings are also available to complete any type of installation. This new plug-in strip can be cut to fit on the job with a hacksaw without taking the assembly apart. Most suitable points of installation are said to be on walls and partitions, at floor, baseboard, or chair-rail height. It also can be mounted either flush with, or on the top surface of molding, tables, or counters. For further information write to National Electric Products Corporation, Chamber of Commerce Building, Pittsburgh 19, Pa.

Servoscope. Precision electronic instrument, developed by the Servo Corporation of America, is the first of a line of servomechanism design aids which will be introduced in the next few months. This test instrument furnishes the control engineer with continuous performance data about the servomechanism or process control he is building or testing. Frequency response can be plotted in a few minutes and transient characteristics deduced. Servoscope provides an invaluable test signal carrier from 50 cps to 800 cps at 115 volts; amplitude range from two millivolts to 100 volts rms; phase lead or lag accuracy to within two degrees (phase dial is calibrated from 0 degrees to 360 degrees in one degree division); power consumption is held to 40 watts. Applications are numerous—check complete loops or any of their components, such as motors, synchros, gyros, amplifiers, accelerometers, and so forth. In fact, any automatic control device may have its design and test time cut in half by use of the Servoscope. For further information write to Servo Corporation of America, New Hyde Park, N. Y.



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SMALLER DIAMETER MEANS MORE CABLES IN A GIVEN SPACE

U. S. Control Cable (7-conductor) insulated with Laytex	Ordinary 7-conductor Control Cable

HIGHLIGHTS........

Technical Conferences. Two more of the new AIEE technical-conference-type meetings were held recently with conspicuous success. The first of these, and the third meeting of this type, was the conference on electronic instrumentation in nucleonics and medicine held jointly with the Institute of Radio Engineers in New York, November 29–December 1. It was attended by more than 500 persons (*page 173*). This conference was followed, December 6–8, by the AIEE conference on electric welding which attracted some 436 persons to the Rackham Memorial Building in Detroit, Mich., where it was held (*page 172*).

President's Message. In this month's message to the membership, AIEE President E. S. Lee takes issue with the statement that "anyone can get into the AIEE." He particularly commends the work of the board of examiners and the committee on transfers in passing on applications for membership or transfer (*page 171*).

Digests. Most of the papers which are digested in this issue were presented at the AIEE Midwest general meeting in Milwaukee, Wis., October 18–22, 1948 (*pages 115, 116, 137, 138, 144, 147, 151, 161, 162*).

Electricity in Agriculture. As in industry, the present trend in agriculture is toward larger and fewer farms performing more and more of the processing operations often now performed away from the point of production. In line with this trend, the part played by electricity in farm production is assuming ever-increasing importance; the problem of the utilities will be to keep up with the new rural demand as it develops (*pages 102–06*).

Electric Welding Digests. Brief authors' digests are included in this issue for most of the papers presented at the recent AIEE conference on electric welding which was held in Detroit, Mich., December 6–8, 1948. These papers will not be published by the AIEE in any other form (*pages 163–70*).

Safety in Machine Tool Control. With the increase in complex machinery, safety features take on added significance. This article considers the subject not only from the standpoint of personal safety, but also from the standpoint of safeguarding the useful life and operation of the machine (*pages 157–60*).

Radiotelephone System. The Great Lakes shipping industry has been greatly benefited through the installation of a radiotelephone system. It was designed especially to fit their needs. Now, most of the 600 Lake vessels are equipped with radio transmitter-receiver sets which provide telephone-dial channel selection and allow use of the radiotelephone system in a manner similar to use of regular wire telephones (*pages 152–7*).

Inductive Co-ordination Practices. When power lines began to extend across rural America, many telephone lines serving these areas became practically unusable on account of electrical interference. Various means of correcting this situation were investigated. By properly co-ordinating power and communication systems lines on an inductive basis it has been possible to operate both services in close proximity (*pages 148–50*).

Radio-Interference Control. Studies have been made in the field of high-voltage power transmission to determine under what conditions radio-frequency propagation can be expected from corona. Experiments show that there are many influencing factors. With these facts, a beginning can be made in radio-interference control (*pages 139–43*).

All-Hydroelectric System. Many major factors must be considered in the planning of a large all-hydroelectric system such as the Southern Ontario System of The Hydro-Electric Power Commission of Ontario in Toronto, Canada. This system supplies power in the southern portion of the province, covering an area of approximately 47,000 square miles and having a population of approximately 3,500,000 throughout its 297 municipalities and rural areas. Particular consideration had to be given to determining the generating capacity requirements, the provision for reserve capacity, uses of surplus energy, and selection of sites for new plants (*pages 117–21*).

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Snap-Acting Switches. Reductions in size, weight, and operating energy requirements have received a great deal of attention in the design of the new snap-acting switches. Such characteristics which distinguish them from other control devices give them unique usefulness. Growth in the variety and extent of their applications has been very rapid in the past 15 years (*pages 128–34*).

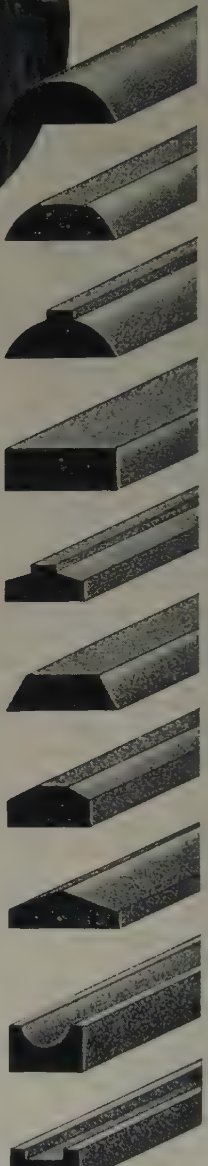
Electronic Protective Relays. With the increasing demand for greater speed, accuracy, and dependability, a need seems to be developing for electronic protective relays which appear, in laboratory test, to be more adequate than present electromagnetic protective relays. This article presents a report of progress in electronic relay developments and attempts to explain the present limited availability of such relays (*pages 122–8*).

Two Sonar Systems. One of the sonar systems described in this article was utilized by the Armed Forces to guard harbor entrances against sneak attacks by enemy submarines. The other, the ultrasonic underwater beacon, guided landing parties in amphibious operations to a preselected beachhead. Both equipments were characterized by the emission of ultrasonic signals from a relatively fixed underwater transducer (*pages 107–14*).

Rectified Aircraft System. A rectified a-c system for use in aircraft has several advantages over conventional d-c systems: it obviates the need for reverse-current cutouts and the problem of co-ordinating the trip characteristics of reverse-current cutout and reverse-current circuit breaker; it permits installation of larger capacity units on main engine accessory drive pads without the use of remote drive couplings; and it provides output at lower engine speeds (*pages 95–101*).

Belated Credit. A photograph comparing interference fringes formed by the green radiation of natural mercury with those formed by mercury 198 (an isotope) which was awarded first prize in the Second Photograph-in-Science Salon of the American Association for the Advancement of Science in September 1948, was published in the December issue (*EE, Dec '48, p 1223*). However, through an oversight, the caption did not indicate that the prize-winning photograph was taken in connection with a project at the National Bureau of Standards which involves basic measurement and nuclear physics, nor was credit given to Doctor W. F. Meggers who has spent considerable effort on this project.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50, Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. February 1949, Vol. 68, No. 2. Number of copies of this issue 51,300



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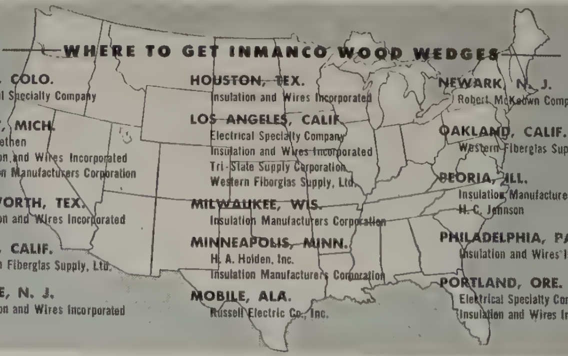

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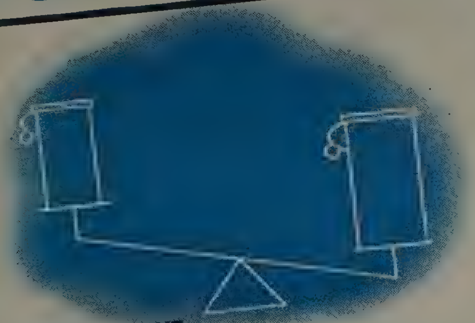

LIGHTER WEIGHT

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2

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3

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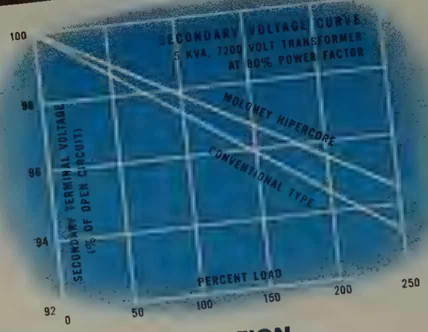
Moloney HiperCore Transformers have improved short-time overload characteristics which provide better peak load performance and longer life. Reduced coil mass, achieved through use of oriented steel cores, together with the extensive use of cooling ducts, results in more rapid cooling of the windings and in a lower hottest-spot temperature gradient.

4



BETTER VOLTAGE REGULATION

The smaller cores of HiperCore Transformers make possible windings having lower impedance. Lower impedance provides lower internal voltage drop at all loads. This is especially important during peak load periods, since HiperCore Transformers can carry higher overloads than older types, at the same permissible regulation.

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Silicone Insulation Gives Rapidly Reversing Motor 10 Times Normal Life

That's significant news to designers of machine tools. Even more significant perhaps to electrical engineers is the further confirmation of our laboratory and motor test results. These tests indicated that Silicone Insulation has 10 times the life and 10 times the wet insulation resistance of Class 'B' insulation under comparable conditions.

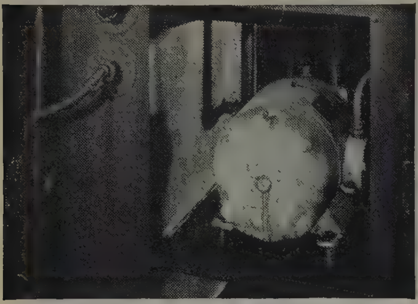


PHOTO COURTESY COGSDILL TWIST DRILL COMPANY

Improved drill grinder depends upon DC Silicone Insulation for long trouble-free operation.

Engineers at Cogsdill Twist Drill Company of Detroit developed a unique machine for grinding drills. Instead of reversing the carriage by a conventional cam or crank, they use a 1 h.p., 1200 r.p.m. motor to reverse the carriage drive 50-60 times per minute.

In this service, Class 'A' insulated motors lasted 3 to 4 days; Class 'B' insulated motors lasted 3 to 5 weeks. After repeated failures, the reversing motors were rewound with DC Silicone Insulation by the A. H. Nimmo Electric Company of Detroit.

The motor bearings were packed with DC 44 Silicone Grease and the frame was painted with DC Silicone enamel. The motors have now been in service over 10 months and show no sign of failure. A hazardous smoke problem caused by the burning of conventional finishes also has been eliminated.

This is a typical example of how Dow Corning Silicone Insulation increases the life and reliability of hard working motors. Specifications for rewinding ac motors are given in data sheet G6A.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
Los Angeles • New York
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

INDUSTRIAL NOTES ....

A. H. Smith Elected Vice-President of Kerite. At a December 1948 meeting of the board of directors of the Kerite Company, Arthur H. Smith was elected a vice-president. He has held the position of railroad sales manager for the company since 1945.

Westinghouse Appointments. Roscoe Seybold, vice president of the Westinghouse Electric Corporation, has been appointed assistant to the president, with special responsibility for organizational planning and budget and operating expense control. C. E. Headlee has been elected controller, a position held by Mr. Seybold since 1931. Also recently appointed are William A. Beatty, who now is manager of the feeder division; and Leonard H. Loufek as industrial manager of the company's central district. He succeeds C. H. Weaver, who has been named manager of the newly-formed atomic power division of Westinghouse.

GE Notes. General Electric company has leased the former Remington Rand Plant in Johnson City, N. Y., from the War Assets Administration, to manufacture special equipment for the Air Force which will furnish production facilities in the plant. Walter B. Booth, formerly division superintendent of the carbon products division of the Schenectady plant, has been appointed plant manager of the new Johnson City factory. New appointments include those of Wilmer P. Hauck, to the position of manager of manufacturing of General Electric Company's heat device factories at Bridgeport. At Schenectady, Arthur H. Hemker has been appointed manager of the farm industry division, while George A. Rietz, former manager, replaces A. C. Stevens, recently retired, as manager of the educational service section in the customer relations division of the General Electric executive department.

Moloney Electric Gets Hungry Horse Contract. The Moloney Electric Company of St. Louis, Mo., has recently been awarded a contract for supplying the main power transformers for the Bureau of Reclamation's Hungry Horse Project, located on a Columbia River tributary, near Kalispell, Montana. The contract covers six 60,000 Kva, single-phase transformers, which will be used to step up the generator bus voltage of 13,800 volts to 230,000 volts for transmission. The company also announces the appointment of Edwin C. Mulcahy as vice president in charge of sales.

New President for RCA. Frank M. Folsom, formerly executive vice president in charge of RCA Victor division, took office as president of Radio Corporation of America in January. Mr. Folsom's former position will be filled by John G. Wilson.

Cornell-Dubilier Purchases RCA Capacitor Plant. All equipment, designs, processes, and patent licenses of the Faradon Capacitor Division of the Radio Corporation of America has been purchased outright by the Cornell-Dubilier Electric Corporation of South Plainfield, N. J. Production of Faradon capacitors is now being continued under the new owner.

Porcelain Insulator Corporation Completes Plant Addition. The first half of a six-year expansion program of the Porcelain Insulator Corporation of Lima, N. Y., has been realized with the completion of a new addition located at the south end of the plant. The addition, 209 feet long, houses a modern machine shop and tool crib, mold manufacturing department, and a plant maintenance department. Other new buildings and plant additions include a mold storage building; a storage building for PINCO transmission line hardware; an oil storage building and a new transformer bushing and switch insulator assembly department, an enlargment of the engineering department, and new, completely equipped, lecture quarters.

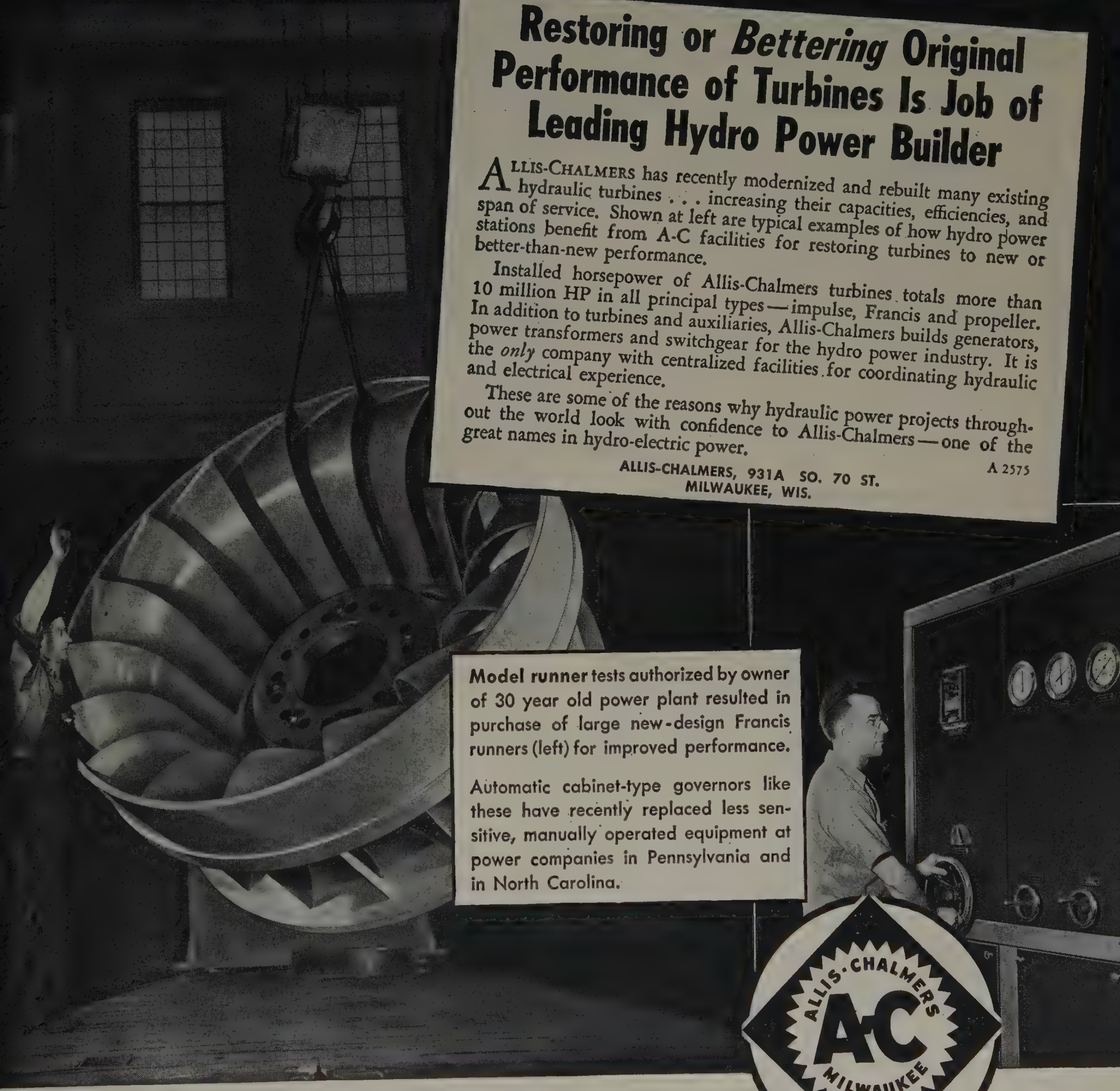
New Test Instrument Company. James W. Dice, formerly with Westinghouse Electric Corporation, and recently assistant sales manager of Sperry Products, has formed a new sales and development organization to be known as J. W. Dice and Company. The new company is located at Grand View-on Hudson, N. Y., and specializes in the marketing of industrial and laboratory nondestructive test instruments employing magnetic, electronic, ultrasonic, and radiation principles.

D. J. Burns Resigns as President of Ward Leonard Electric. Dawson J. Burns, at a recent meeting of the board of directors of the Ward Leonard Electric Company, resigned as president. He then was elected to the office of chairman of the executive committee. Mr. Burns had been a member of the board of directors since 1903, serving the company as vice-president from 1908 to 1944 at which time he was elected president. Arthur A. Berard, executive vice-president and general manager of the company since 1944, was elected president and general manager. Mr. Berard, who joined the company in 1920, has been a member of the board of directors since 1927 and has served as factory manager and general sales manager.

Fairchild Recording Equipment Corporation Formed. To combine the manufacture and sale of a new professional studio quality magnetic-tape recorder with the line of professional disk-recording and sound equipment of Fairchild Camera and Instrument Company, a new company has been formed with offices at 30 Rockefeller Plaza, New York, N. Y. It will serve the specialized requirements of the radio-broadcast industry, as well as the strict requirements demanded by the art of record and transcription manufacture, and also

(*Continued on page 26A*)

HYDRO POWER



Restoring or *Bettering* Original Performance of Turbines Is Job of Leading Hydro Power Builder

ALLIS-CHALMERS has recently modernized and rebuilt many existing hydraulic turbines . . . increasing their capacities, efficiencies, and span of service. Shown at left are typical examples of how hydro power stations benefit from A-C facilities for restoring turbines to new or better-than-new performance.

Installed horsepower of Allis-Chalmers turbines totals more than 10 million HP in all principal types—impulse, Francis and propeller. In addition to turbines and auxiliaries, Allis-Chalmers builds generators, power transformers and switchgear for the hydro power industry. It is the *only* company with centralized facilities for coordinating hydraulic and electrical experience.

These are some of the reasons why hydraulic power projects throughout the world look with confidence to Allis-Chalmers—one of the great names in hydro-electric power.

ALLIS-CHALMERS, 931A SO. 70 ST.
MILWAUKEE, WIS.

A 2575

Model runner tests authorized by owner of 30 year old power plant resulted in purchase of large new-design Francis runners (left) for improved performance.

Automatic cabinet-type governors like these have recently replaced less sensitive, manually operated equipment at power companies in Pennsylvania and in North Carolina.

CHALMERS

Electrical Equipment from Generation through Utilization

Welwyn Electrical Laboratories of Blyth, England, take pleasure in announcing the availability in the American Market of

1% HIGH STABILITY Carbon Resistors

proven over a decade in radar, communication and nucleonic apparatus. These cracked carbon resistors are available from 100 ohms to 50 megohms, with negligible voltage coefficient and temperature coefficient so low that all factors will not exceed the 1% tolerance—an accuracy they will hold for their life. *Individually noise tested before shipment,* they approach wirewound units in performance, and the minimum circuit noise determined by Johnson Formula.

Other Welwyn Resistor Products: Wirewound Resistors—in Vitreous Enamel and Cement Coatings—sized for 3 to 300 watts and capable of full dissipation.

Trimmer capacitors—air spaced with high ratio of maximum to minimum capacity—500 working volts—RMS.

Write for Descriptive Literature.

WELWYN ELECTRONIC COMPONENTS, INC.
234 East 46th Street New York 17, N. Y.
MUrray Hill 2-2535

DO *YOU* KNOW THE DIFFERENCE BETWEEN "ELECTRIC" & "ELECTRICAL"?

Electric means containing, producing, arising from, actuated by, or carrying electricity, or designed to carry electricity and capable of so doing.

Electrical means related to or associated with electricity but not having its properties or characteristics.

Definitions of some 4000 electrical terms—an invaluable aid to engineers, editors, scientists, technicians, and teachers—are published in the——

American and Canadian Standard—

DEFINITIONS OF ELECTRICAL TERMS

Price : $1.00
($1.25 outside postal USA)

Published by
American Institute of Electrical Engineers
33 West Thirty-Ninth St., New York 18

(*Continued from page 16A*)

will apply magnetic tape recording to industrial, motion picture, and aviation uses. Officers of the group are Sherman M. Fairchild, president; Wentworth Fling, operating vice-president; Hay H. Quinn, director of sales and advertising; C. V. Kettering, head of a sales division specializing in educational and industrial applications; Theodore Lindenberg, head of the instrument laboratory; and Gordon Mercer in charge of the electronic laboratory. John B. Wolf becomes secretary-treasurer. Doctor D. C. Hare has been retained by the new corporation as technical consultant and advisor.

Joint Electron Tube Engineering Council Appointments. Doctor A. K. Wright, chief radio engineer of the Tungsol Lamp Works, Inc., has been appointed member of the Joint Electron Tube Engineering Council. Doctor Wright has been active in the council's standardization program since its inception and was a former chairman of the receiving tube committee. Other appointments include Frank Langstroth of the Lansdale Tube Company, chairman of the receiving tube committee, and A. K. Wing, Jr., of Federal Telecommunication Laboratories, Inc., chairman of the high vacuum tube power committee.

Radio Manufacturers Failed Last Year. Twenty-nine radio and component manufacturers failed financially during the last fiscal year 1947–48 with liabilities totaling $123,912,000, the RMA Credit Committee reported during the 24th annual convention of the Radio Manufacturers Association at the Stevens Hotel, Chicago, Ill. The 29 manufacturers were classified as follows: radio receiver, 10; communications equipment, 5; test equipment, 3; television receivers, 2; recorders, 2; radio parts, 2; phonographs, 2; sound equipment, 1; motors, 1; projection, 1.

TRADE LITERATURE

Pressure and Vacuum Gauges; pH and Conductivity Control. The Brown Instrument Company has issued two new catalogs, the first, catalog number 15-12, features pH and conductivity control and their application to different industrial processes, as well as a discussion of the fundamentals involved. Catalog number 7000 offers a full description of pressure and vacuum gauges (indicating, recording, and controlling). Request copies from the Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia 44, Pa.

Advance Relay Catalog. An illustrated catalog containing the entire line of advance relays, complete with descriptive detail. Write to Advance Electric and Relay Company, 1260 West 2nd Street, Los Angeles 26, Calif.

How Power at Load Centers Pays Off. This 16-page bulletin, recently issued by

(*Continued on page 30A*)

here's on-the-job proof of Westinghouse Instrument Performance

where reliability and readability really count

Westinghouse instrument specialists are available in the field for consultation on your instrument problems. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

Send for Booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-3363.

Radio stations can take no chances on "outages"—time off the air is costly. For split-second timing, efficiency, and continuity, all vital operating information must be readily available to the control engineer at a glance.

For these reasons, instruments of unfailing performance and quick readability are a *must*. The Westinghouse instruments at KMOX solved these problems. They also provide co-ordinated styling and smart appearance.

What are YOUR electrical measuring problems?

Would they include—reliable performance . . . styling . . . size . . . readability or different types of service . . . portable . . . switchboard . . . panel . . . recording?

The vast lines of Westinghouse electrical measuring instruments provide you with the answers to all of these problems. Every Westinghouse instrument is backed up by more than 60 years of skill, "know-how", and experience in every field of industry.

J-40362

Westinghouse Instruments Also Provide You With

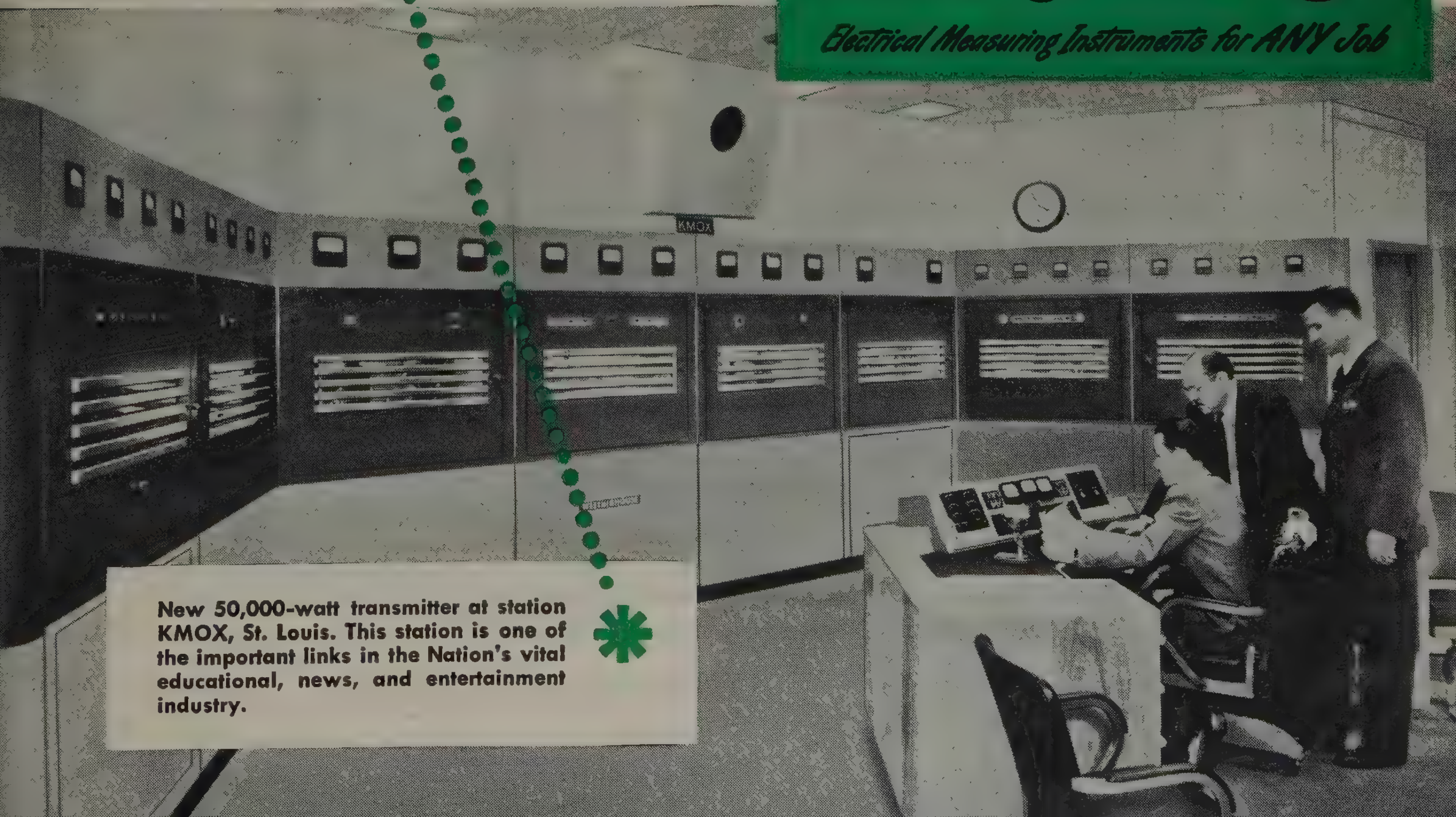
- Dials that *stay* white under all conditions
- Magnets that stay permanent
- Pivots with high shock capacity and low friction
- Springs that remain constant for life
- Quick delivery of more different ratings and types
- Complete Nationwide Service

YOU CAN BE SURE . . . IF IT'S

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electrical Measuring Instruments for ANY Job

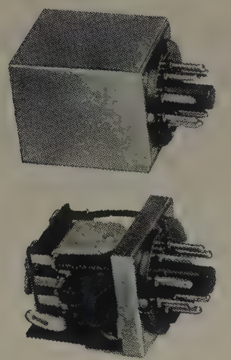


New 50,000-watt transmitter at station KMOX, St. Louis. This station is one of the important links in the Nation's vital educational, news, and entertainment industry.

3 IMPORTANT NEW Relay Developments

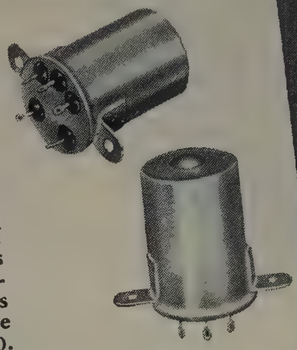
NEW! ...TINY OCTAL BASE RELAYS for AC, DC or half-wave rectified AC

TYPE 118XBX: Available in either open or metal-enclosed types as illustrated, also hermetically sealed. Highly sensitive on DC. DP-DT contacts rated 2 amps. at 115 V. AC. DC operating power is .15 watts with maximum coil resistance of 2,200 ohms. Write for Bulletin 2400.



NEW! ...HERMETICALLY SEALED DC RELAYS FOR HIGH-ALTITUDE AVIATION

These little CX3554 Relays are insensitive to humidity changes and capable of operation at 70,000 feet. Features include shock resistance to 50 G's; vibration resistance better than 10 G's; high-speed operation without contact bounce, and reliability over an ambient range of −75° C. to +200° C. SP-DT contacts nominally rated 2 amps. withstand inrushes of 12 amps. at 26.5 V. DC. Coil is rated 26.5 V. DC with operating range of 18/32 V. DC. Write for Bulletin 2410.



Stepless, wide-speed range. Complete timing reliability

NEW! ...MONEY-SAVER FOR TIMING CONTINUOUS PROCESS WORK

Besides eliminating the need for numerous cascaded timers, the new Struthers-Dunn DB Timer usually requires much less auxiliary control equipment. An entire process combining many operations can quickly be set up on a single dial. Total time cycle adjustments as well as the timing of individual periods are easily made. Write for DB Timer Bulletin 7110.

STRUTHERS-DUNN

5,348 RELAY TYPES

STRUTHERS-DUNN, INC., 150 N. 13TH ST., PHILADELPHIA 7, PA.

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO
CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS
LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PITTSBURGH
ROCHESTER • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

(Continued from page 26A)

Allis-Chalmers, describes the advantages of their new standardized load center unit substations. Write for bulletin 11B6285A, to Allis-Chalmers Manufacturing Company, South 70th Street, Milwaukee, Wis.

Temperature Instruments for Power Equipment. Revised catalog ND-33-461, published by Leeds and Northrup Company, and directed to those responsible for safe operation of electric power equipment without danger of overheating. Request should be addressed to Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pa.

IRC Advanced Type Resistors. Data on characteristics and specifications of new type BT insulated fixed composition resistors, given in a 12-page illustrated booklet, by the International Resistance Company, 401 N. Broad Street, Philadelphia 8, Pa.

New Locke Catalog Sections. Locke, Inc. has just released two new catalog sections—"Switch and Bus Insulators," and "Fittings for Suspension Insulators." Data tables and NEMA (National Electrical Manufacturer's Association) standards are included. Copies may be obtained by writing to the Merchandising Division, Locke Inc., P. O. Box 57, Baltimore 3, Md.

The Improvement of Metals by Forging. A new 44-page catalog published by the Steel Improvement and Forge Company describes in detail the various types and characteristics of forgings, their designs, and other relative specific information. Copies are available from the Steel Improvement and Forge Company, 969 East 64th Street, Cleveland, Ohio.

Midget Relays. Bulletin number 2100, issued by Struthers-Dunn, Inc., simplifies the selection and use of midget relays. Underwriters approved relay with 15-ampere (at 115 alternating volts) contacts are listed for the first time. Address copy request to Struthers-Dunn, Inc., 150 N. 13th Street, Philadelphia, Pa.

Aroclors. The physical properties and suggested applications of Aroclors, produced exclusively by Monsanto Chemical Company, are given in a 27-page booklet recently published by that company. Write to the department of industrial and public relations, Monsanto Chemical Company, St. Louis 4, Mo.

Dow Corning Silicone Notebook. A 31-page booklet concerned with the properties and behavior of the *DC 200* silicone fluids. Titled "DC 200 silicone Fluids, Dow Corning Silicone Notebook, Fluid Series number 3," the notebook may be acquired by writing to Dow Corning Corporation, Midland, Mich.

Speed Measuring Instruments. Description, operation, and selection of chronometric, centrifugal, and resonant reed tachometers presented in a 28-page bulletin pub-

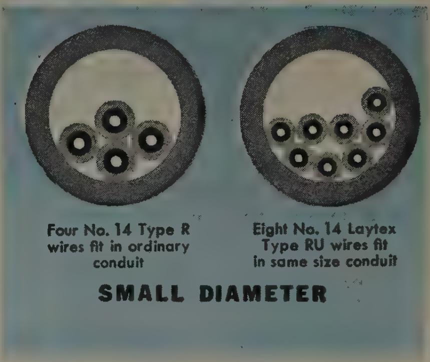
(Continued on page 44A)

"This Wire's got Safety and long Life...It's Laytex RU."

PERFECT CENTERING

So says Mr. USRUBBY, the Wire Engineer. And you, Mr. Engineer, will agree with him. For when you specify U. S. Laytex RU, you are getting a wire that will not suffer from the dangerous thin spots formed on ordinary wires. Why? Because United States Rubber Company's unique dip or pass method applies the insulation in *perfectly uniform* layers. Moreover, this insulation is 90% pure rubber, unmilled in order to preserve its high physical qualities. The extra strength of natural rubber, plus a strong fibrous cover and special finish gives extra protection against mishandling, sharp bends, moisture and flame.

90% NATURAL RUBBER INSULATION



Four No. 14 Type R wires fit in ordinary conduit

Eight No. 14 Laytex Type RU wires fit in same size conduit

SMALL DIAMETER

Yet, despite the unusual safety features of Laytex RU, this wire is smaller in diameter and lighter in weight than any other natural rubber covered wire on the market. Not only is Laytex unsurpassed in physical and electrical qualities, but it will also permit *more wires per conduit.*

The tensile strength of Laytex RU is over 7 times that of Type R, and twice that of Type T. Its insulation resistance constant is over 3 times that of Type T, and over 8 times that of Type R. Add all these advantages up, and no wonder Laytex RU is the finest building wire on the market today.

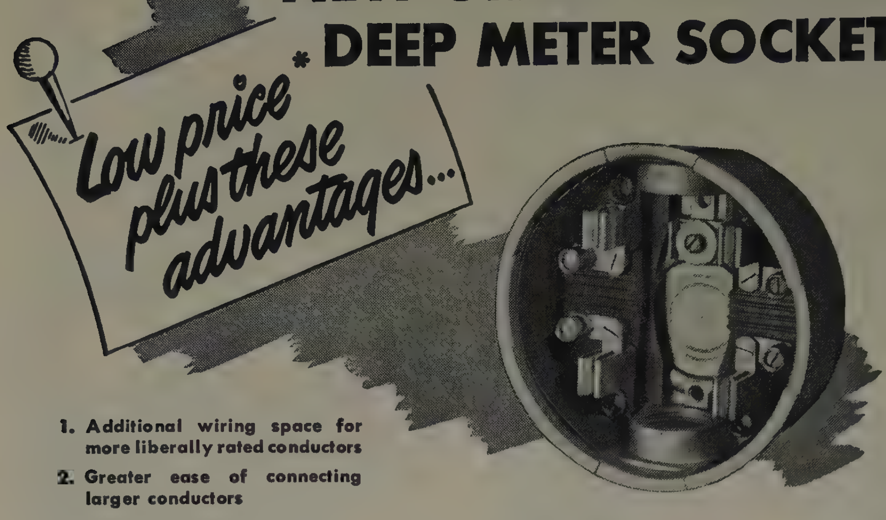
U. S. Laytex RU is labeled by the Underwriters' Laboratories and listed in the National Electrical Code as an all-purpose wire. Send for a sample and free booklet. Write Wire and Cable Department, United States Rubber Company, 1230 Avenue of the Americas, New York 20, N. Y.

Reg. U. S. Pat. Off.

RU wiring with RU?

A PRODUCT OF
U.S. RUBBER
SERVING THROUGH SCIENCE

UNITED STATES
RUBBER COMPANY



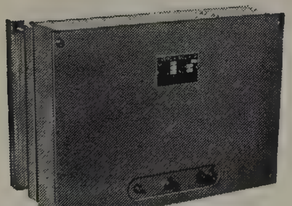
NEW STANDARDIZED
* DEEP METER SOCKET

1. Additional wiring space for more liberally rated conductors
2. Greater ease of connecting larger conductors
3. Increased current-carrying capacity
4. New and improved all-welded, one-piece, stainless steel ring
5. Snap-action, quick-hitch ring that requires no tools for installation
6. Bonderized plus baked-on aluminum paint for increased corrosion resistance and longer life
7. Two-way ($3.00 list) three-way ($3.85 list), subject to change without notice.

This new type R-1 four-terminal standardized socket covers with one catalog item the widest practicable range of applications and ratings for single-phase metering. It reduces the number of items to be stocked, increases interchangeability, and provides for future growth.

Detailed specifications and prices are available from your nearest G.E. representative. Consult him today, or write for Bulletin GEA-5147. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC
601-42



the first line of standard electronic voltage regulators

Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under SIMULTANEOUS line and load changes.
SIX IMPORTANT SORENSEN FEATURES:

1. Precise regulation accuracy;
2. Excellent wave form;
3. Output regulation over wide input voltage range;
4. Fast recovery time;
5. Adjustable output voltage, that once set, remains constant;
6. Insensitivity to line frequency fluctuations between 50 and 60 cycles.

The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

SORENSEN and company, inc.
375 fairfield avenue, stamford, connecticut

(Continued from page 30A)

lished by the James G. Biddle Company. Write for bulletin 35-7 to James Biddle Company, 1316 Arch Street, Philadelphia 7, Pa.

New General Switch Catalog. A recently issued 68-page catalog published by the General Switch Corporation gives full details of their complete line of switches. Distribution of the booklet is confined to persons engaged in specifying electrical equipment. Requests should be addressed to General Switch Corporation, 44 Roebling Street, Brooklyn 11, N. Y.

NEW PRODUCTS • • •

Magnet Charger. The Model 107 Magnet Charger, manufactured by Radio Frequency Laboratories, Inc., Boonton, N. J., contains a 100-microfarad capacitor, an associated 500 volt power pack, and a current transformer through which the capacitor bank is discharged in .002 second. The transformer secondary is connected to a charging bar, which is arranged for convenient association with the magnet for induction of the charging magnetic flux, in excess of 15,000 amperes peak value. This peak current can be increased by the Model 206 Booster Unit. The charger is portable, weighing 75 pounds, and can be connected to any 110/120-volt, 50/60-cycle a-c outlet.

Polyethylene Covered Wire. ReLene weatherproof wire, covered with polyethylene, has been added to the line and cable products of Rome Cable Corporation, Rome, N. Y. The new wire is moisture resistant, lighter weight, and of smaller diameter, has resistance to abrasion, sunlight, and other weather hazards. Because it is not the conventional fibrous braided type, longer spans for the same loading conditions are possible.

Recording Vibrometer. General Electric's general engineering and consulting laboratory has developed a new recording vibrometer which measures and records frequency, displacement, and wave shape of mechanical vibration. Built to operate either when mounted on a fixed base or held in the hands (the vibrometer weighs only seven pounds), the instrument is intended for application in testing all types of reciprocating and rotating machinery within a vibration frequency range of 10 to 120 cycles per second. It records both steady-state and transient vibrations. Both the chart speed and the interval between timing marks are governed by a synchronous motor operated from a 115-volt, 60-cycle power supply. Further information may be obtained by writing for bulletin GEC-310, to the General Electric Company, Schenectady 5, N. Y.

"Multipath" Resistor. A new type of resistor, "Multipath," based on the use of slit and formed alloy sheet, is now being produced in the United States by the Exmet Electrical Corporation in conjunction with the National Lock Washer Company, under

(Continued on page 48A)

MEASUREMENTS CORPORATION
Model 59

2.2 mc. to 400 mc.

MEGACYCLE METER

Radio's newest, multi-purpose instrument consisting of a grid-dip oscillator connected to its power supply by a flexible cord.

Check these applications:

- For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, coils.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

SPECIFICATIONS:
Power Unit: 5⅛" wide; 6⅛" high; 7½" deep. Oscillator Unit: 3¾" diameter; 2" deep.

FREQUENCY:
2.2 mc. to 400 mc.; seven plug-in coils.

MODULATION:
CW or 120 cycles; or external.

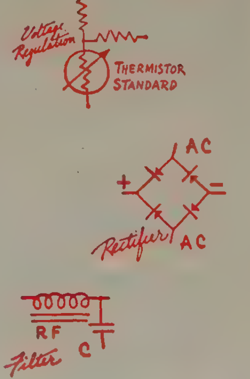
POWER SUPPLY:
110-120 volts, 50-60 cycles; 20 watts.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

putting the finger on power control problems

If you're concerned with problems involving the control of electrical power, you'll do well to get acquainted with Power Equipment Company. For PEco engineers have specialized in controlled rectifiers exclusively over the past 14 years . . . have pioneered in the development of a multitude of circuits aimed at simplification of equipment, reduction in size and weight, lower maintenance cost, greater accuracy of control, automatic operation, and longer rectifier life.

Take PEC 272, the rectifier power supply unit illustrated, for example: It's portable . . . designed for quick, convenient use when and where you need it. Provides unusual flexibility of testing power. Eliminates necessity of maintaining banks of batteries. Gives you accurate control of filtered, closely regulated power for a wide range of applications. And it incorporates the specialized functional design features and precise electrical characteristics achieved by PEco engineers in many other unusual types of equipments. Write for Bulletin No. 848.



POWER EQUIPMENT Company

Battery Chargers ☆ Battery Eliminators ☆ D.C. Power Supply Units ☆ Regulated Exciters ☆ Voltage Stabilizers ☆ and other Special Communications Equipment

55 ANTOINETTE STREET DETROIT 2, MICHIGAN

SORGEL
AIR-COOLED
TRANSFORMERS

Prompt Deliveries of Dry-Type Transformers

50 Kv-a. and smaller
usually from stock

1/4 Kv-a.
Single Phase
460/230 to
115 volt

A size and type for
every purpose.
1/4 Kv-a. to 2000 Kv-a.
All voltages.
Single phase and 3-phase.

3 Kv-a. 3-phase
Wall Mounting Type

Liberal Design.

Steel Encased.

Solderless
Terminals.

Connection
Compartment.

Quiet Operation.
Low Temperature.
High Efficiency.
Long Life.
Priced Right.

100 Kv-a. Single Phase
Floor Mounting Type

SORGEL ELECTRIC CO. 846 W. National Ave., Milwaukee 4, Wis.
Pioneers in the development and manufacturing of Air-Cooled Transformers

(Continued from page 44A)

license covering a number of patents of British origin, as the resistor was originally developed within the British Admiralty during the war. The new-type resistor is distinguished from all other available types by its use of precision-cut sheet metal for resistance instead of wires, ribbons, castings, or stampings. It is available in the form of standardized units, rated 20 to 80 amperes (4.5 to 0.3 ohms), but can be supplied in special design. Information may be obtained by writing to the Exmet Electrical Corporation, 59 Park Avenue, New York 16, N. Y.

Automatic Floating Battery Chargers. The Power Equipment Company, 55 Antoinette Street, Detroit 2, Mich., has developed a new line of electronically controlled and regulated floating battery chargers, for power stations, communications, and other applications requiring accurate control of floating voltage. The chargers are fully automatic, have constant potential output, and are designed to maintain floating charge on the battery group to within plus or minus one per cent. Regulation is independent of a-c line voltage and frequency fluctuations.

Transformer Turn Ratio Test Set. A portable, direct-reading instrument for measuring turn ratio in power transformers, designed for use on all types and sizes of power, distribution and auto transformers in common use, has been developed by the James G. Biddle Company, 1316 Arch Street, Philadelphia 7, Pa. Ratios up to 130 can be measured with an accuracy to within one part in 1,000. It is intended for use both in the shop and in the field.

Kollsman Synchrotel. A new version of the Kollsman Synchrotel increases electrical output by 500 per cent, and decreases the volume to 1/3 of the former unit. This reduced volume also reduces the price of the standard instrument. The new Synchrotel functions as an inductive electric pickoff wherever driving torque is so small that a conventional synchro cannot be used. Its lightweight rotor, 3/4 gram, makes it useful where very high accelerations and rapid oscillations are to be measured. A descriptive pamphlet concerning the instrument may be obtained by writing to the Kollsman Instrument Division of Square D Company, Elmhurst, N. Y.

Current Transformers. Model 313 "Donut" type instrument current transformers, manufactured by Associated Research, Inc., 231 S. Green Street, Chicago 7, Ill., are of the insert primary type, insulated for 4,500 alternating volts and can be used on 25 to 133 cycles. The transformers are available in ratios from 25/5 to 1000/5 amperes and in multirange combinations with single primary and tapped secondaries so as to provide several ranges without making elaborate circuit changes necessary.

Electric Contacts. Made from copper tungsten by the powder metallurgy process, the Gibsiloy *UW6* electric contact, manufactured by the Gibson Electric Company, is capable of interrupting very heavy currents with minimum erosion. For information contact the Gibson Electric Co., 8350 Frankstown Avenue, Pittsburgh 21, Pa.

HIGHLIGHTS........

Winter General Meeting. More than 2,800 persons gathered at the Hotel Statler during the week of January 31–February 4 to participate in the largest technical program ever assembled for a meeting in the history of the Institute. This was also the first time that a winter general meeting in New York has been held away from the Engineering Societies Building on West 39th Street (*page 262*). A total of 55 technical sessions and conferences were held presenting 226 papers. The highlights of a number of the sessions are reported in this issue (*pages 262–7*). The remainder are scheduled for inclusion in the April issue.

Conference Papers Digested. Short authors' digests of most of the papers presented at two recent joint conferences are included in this issue: the conference on electronic instrumentation in nucleonics and medicine in New York, N. Y., November 29–December 1 (*pages 246–51*), and the conference on high-frequency measurements in Washington, D. C., January 10–12 (*pages 251–7*).

Coming AIEE Conferences. Two more in the AIEE's very interesting conference series are planned for the near future. On April 11 and 12, 1949, a conference on the industrial application of electron tubes will be held in the Statler Hotel at Buffalo, N. Y. (*page 260*). A conference on the rubber and plastics industries is scheduled to convene in Akron, Ohio, on April 26 (*page 260*).

1949 AIEE Nominees. James F. Fairman of the Consolidated Edison Company of New York, Inc., has been nominated for the AIEE presidency for the year 1949–50. Other nominees for office at this time include vice-presidents from Districts 2, 4, 6, 8, and 10 (*pages 260–1*).

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Two Future AIEE Meetings. With Dallas, Tex., as host city, the 1949 AIEE South West District meeting will be held April 19–21. The technical program and general sessions will carry out the meeting theme, "What Electrical Engineers Are Doing to Meet the Needs of the Growing Southwest" (*pages 258–9*). The AIEE summer general meeting for 1949 is scheduled to be held in Swampscott, Mass., June 20–24, with headquarters at the New Ocean House (*page 260*).

Digests. In accordance with current practice, a number of one page digests of technical program papers appear in this issue (*pages 197, 198, 204, 212, 213, 214, 224, 225, 226, 235, 236, 243, 244*).

The Professional Estate. The engineer, as a professional man, must learn that "professionalism is not so much a matter of license, or definition, or certification, as it is a matter of the way a man applies himself to the business of working and living. It is a matter of meeting ethical standards and balancing learning with human experience." President Charles Wilson of the General Electric Company makes his point in an address presented at the AIEE winter general meeting (*pages 187–90*).

Effects of Electricity. "Today in the United States and Canada the number of fatalities annually ascribed to electricity is seven per million of population, and approximately half of the accidents are fatal." The effects of the passage of an electric current through the human body, and the factors which determine them, are described by the dean of engineering at Johns Hopkins University (*pages 199–203*).

Transistors. Two articles on this recently developed device, which performs the functions of the vacuum tube triode, are included in this issue. "The Transistor—A New Semiconductor Amplifier," describes the construction, characteristics, and behavior of the transistor (*pages 215–21*), and "The Coaxial Transistor," describes and tells the advantages of this newest type of transistor (*pages 222–3*).

Electric Appliances. The design and building of electric appliances for the home presents many problems to electrical engineers in this field. Their ingenuity has made domestic appliances available in 30 million American homes and has introduced an army of mechanical servants that were undreamed of before (*pages 205–11*).

AIEE PROCEEDINGS

Order forms for current AIEE *PROCEEDINGS* have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of AIEE *PROCEEDINGS* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *TRANSACTIONS.*

AIEE *PROCEEDINGS* are an interim membership service, issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec '46, pp 567–8*; *Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *PROCEEDINGS* will appear in *ELECTRICAL ENGINEERING* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter general
Aug '48, p 45A	Great Lakes District North Eastern District Summer general
Oct '48, p 43A	Pacific general Middle Eastern District
Dec '48, p 35A	Midwest general Southern District

Edison Medalist. The coveted Edison Medal for 1948 went to Morris E. Leeds, inventor and scientist, for his work in the development and production of electric precision measuring devices and controls. Full texts of the presentation and acceptance addresses, made at ceremonies held during the recent AIEE winter general meeting, are in this issue (*pages 192–6*).

Aircraft Electric Systems. Safety in design and safe working techniques in aeronautical electric systems are considered in this article. The present use of higher voltages of 120 volts direct current and 120/208 volts 3-phase alternating current has elevated this problem (*pages 227–9*).

Electrostatic Precipitation. A variety of uses for electrostatic precipitation have been found so that it no longer represents a "one application" industry. Functions and electric requirements of precipitators are described (*pages 229–34*).

Television Picture Quality. In this article on the highlight brightness and contrast range in television, it is evident from the examples and illustrations that the contrast range is more important than mere brilliance in the picture. Increased brightness is of use to the eye only if it brings with it increased contrast (*pages 237–42*).

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. March 1949, Vol. 68, No. 3. Number of copies of this issue *51,600*

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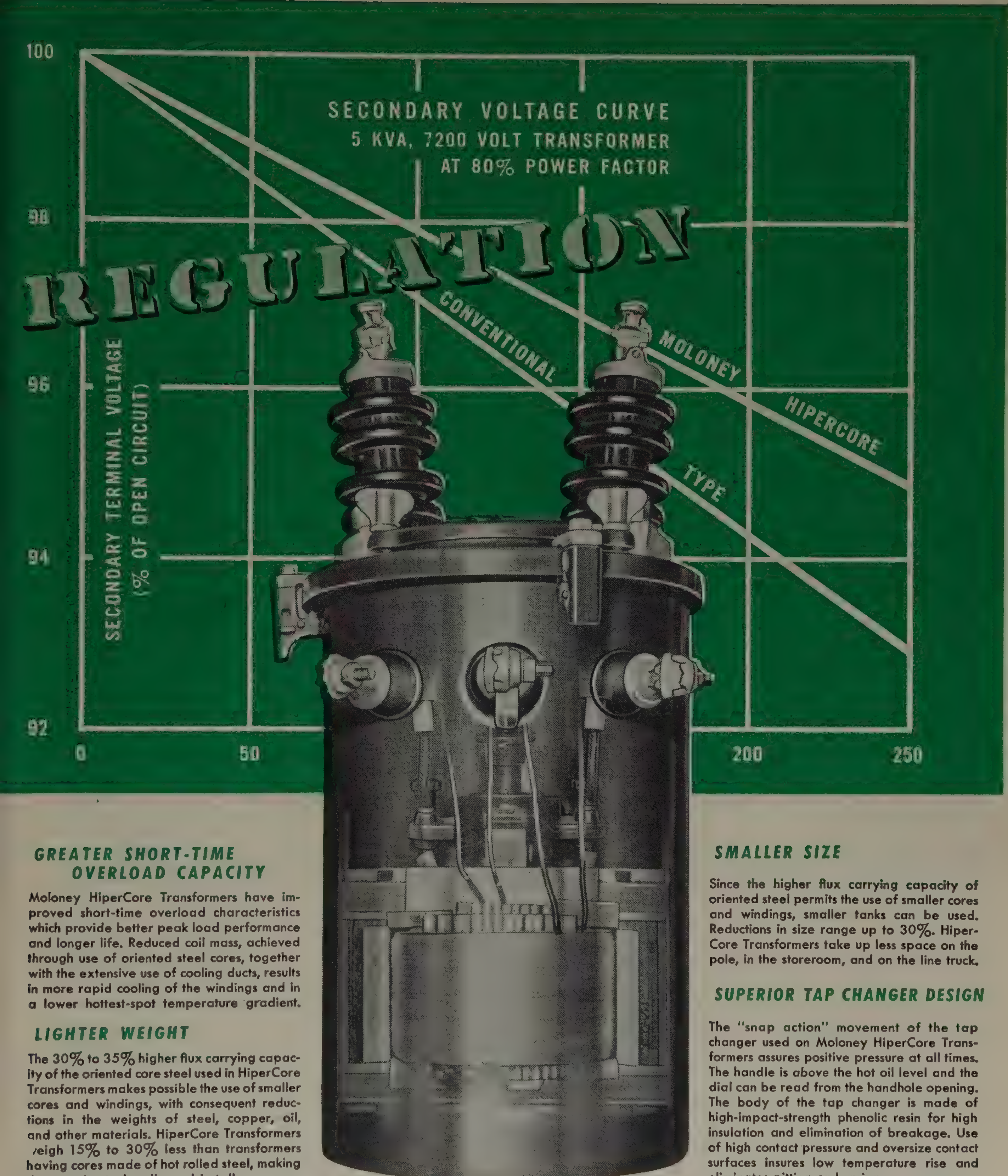

GREATER SHORT-TIME OVERLOAD CAPACITY

Moloney HiperCore Transformers have improved short-time overload characteristics which provide better peak load performance and longer life. Reduced coil mass, achieved through use of oriented steel cores, together with the extensive use of cooling ducts, results in more rapid cooling of the windings and in a lower hottest-spot temperature gradient.

LIGHTER WEIGHT

The 30% to 35% higher flux carrying capacity of the oriented core steel used in HiperCore Transformers makes possible the use of smaller cores and windings, with consequent reductions in the weights of steel, copper, oil, and other materials. HiperCore Transformers weigh 15% to 30% less than transformers having cores made of hot rolled steel, making them easier to handle and install.

SMALLER SIZE

Since the higher flux carrying capacity of oriented steel permits the use of smaller cores and windings, smaller tanks can be used. Reductions in size range up to 30%. HiperCore Transformers take up less space on the pole, in the storeroom, and on the line truck.

SUPERIOR TAP CHANGER DESIGN

The "snap action" movement of the tap changer used on Moloney HiperCore Transformers assures positive pressure at all times. The handle is above the hot oil level and the dial can be read from the handhole opening. The body of the tap changer is made of high-impact-strength phenolic resin for high insulation and elimination of breakage. Use of high contact pressure and oversize contact surfaces insures low temperature rise and eliminates pitting or burning.

ELECTRIC COMPANY

SAINT LOUIS 20, MISSOURI AND TORONTO, ONTARIO, CANADA

Silicone News

DC SILICONES

What's Essential?

Buttons and bows may be essential to the little woman; a box of La Coronas may be essential to us. But that's a purely relative use of the word. For something that is absolutely essential we point to certain industrial motors . . . for example, pump motors that supply water to a processing plant. They're the kind of motors that deserve Silicone Insulation.

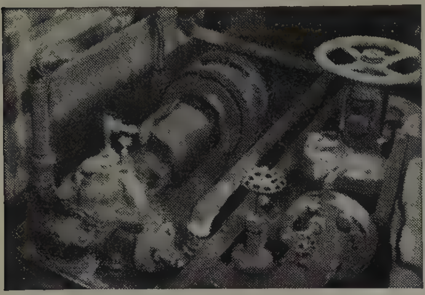

PHOTO COURTESY PURE OIL COMPANY

Both of the 10 h.p. motors which supply water to the Pure Oil Refinery at Midland, Michigan, are silicone insulated to assure continuous operation under adverse conditions.

These two pump motors are located in a subbasement near a river that overflows every spring. Ventilation is poor and humidity is always high. Originally insulated with Class "A" materials, both motors failed the first time they were flooded out. They were then rewound with Silicone (Class "H") Insulation.

Pure Oil specified Silicone Insulation because it offers much more protection to motors exposed to excessive moisture. In several instances, silicone insulated motors that were submerged by flooding have been hosed off and put right back into service. Accelerated life testing and actual performance records have proved that this new class of insulation developed by Dow Corning has at least 10 times the life and 10 times the wet insulation resistance of the best insulating materials previously available.

Electrical maintenance and production men in all fields of industry are learning that Silicone Insulation is the best insurance there is for critical motors. For more information, call our nearest branch office or write for pamphlet No. G7-A.

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INDUSTRIAL NOTES ....

Moloney Electric Company Expansion. A new addition to the Moloney Electric plant at St. Louis, Mo., built expressly for winding cores and assembling their new line of wound core type distribution transformers, has been completed, which will more than double the present output of transformers in sizes 50 kva and smaller. This concludes a major part of the expansion program begun over a year ago by the company, which included the doubling of crane facilities to permit handling of extremely large transformers in voltage ratings as high as 230 kv, the increasing of vacuum tank space by 50 per cent, and the construction of a new warehouse building at the plant.

Sprague Electric Acquires Herlec Corporation. The Sprague Electric Company of North Adams, Mass., has acquired the Herlec Corporation of Milwaukee, Wis., manufacturers of ceramic capacitors and "Bulplate" printed circuits. Manufacturing operations are now being expanded at the Milwaukee plant, while a new Sprague plant for manufacturing ceramic assemblies is being built at Nashua, N.H. Milwaukee operations will continue under the current direction of Herlec Corporation executives Milton Ehlers, president; Harry Rubenstein, vice-president and chief engineer; and Thomas Hunter, vice-president in charge of sales.

F. A. Smith Company Changes Name. Fasco Industries, Inc., is the new name for the F. A. Smith Manufacturing Co., Inc., of Rochester, N.Y., makers of automotive electrical equipment. The change of name was decided upon to facilitate identification with the company's products, which go under the trademark, "Fasco." This renaming has involved no alterations in any of the former policies, officers, or directors of the company.

Cornell-Dubilier Purchases Radiart Corporation. The Cornell-Dubilier Electric Corporation, capacitor manufacturers of South Plainfield, N.J., has recently purchased all the stock of Radiart Corporation of Cleveland, Ohio, from Maguire Industries, Inc. Radiart manufactures autobile radio vibrators and television and automobile antennas in three plants in Cleveland, which will operate as a separate division of Cornell-Dubilier.

Allis-Chalmers Awarded $4,000,000 Contract. The Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been awarded an over $4,000,000 contract by the U. S. department of interior, bureau of reclamation, covering power generation equipment for Hoover Dam on the Colorado River. The award covers two 115,000-hp 480-foot 180-rpm hydraulic turbines and two 82,500-kva 16,500-volt generators similar to units previously installed at the same station. Allis-Chalmers has already supplied seven of the 12 large hydraulic turbines installed at Hoover dam.

Polytechnic Research Labs. The Polytechnic Research and Development Company, Inc., formerly located at 66 Court Street, Brooklyn, N. Y., has opened new and expanded research laboratories at 202 Tillary Street, also in Brooklyn. The company is under the technical direction of F. J. Gaffney (A '37), and Doctor H. S. Rogers is president.

Westinghouse Appointment. James Clarke, director of audits for the Westinghouse Electric Corporation since 1946, has been elected assistant controller of the company.

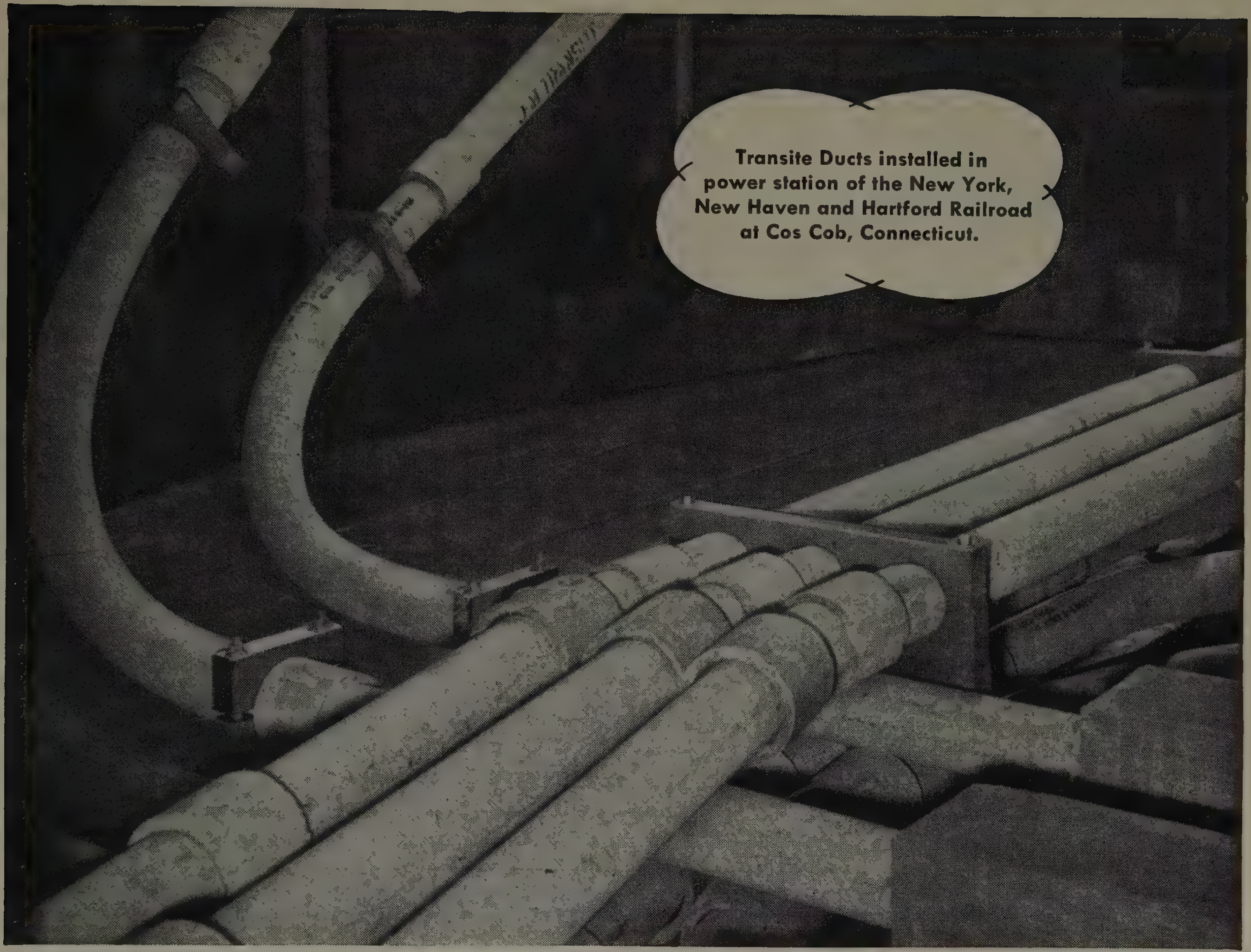
RCA Elections. The Radio Corporation of America, New York, N. Y., recently elected Joseph H. McConnell vice-president in charge of finance, and Walter A. Buck operating vice-president of the RCA Victor Division. Mr. McConnell has been vice-president in charge of law and finance of the RCA Victor Division since 1947; Mr. Buck, a retired rear admiral of the United States Navy, was formerly president of Radiomarine Corporation of America, a service of RCA.

GE Merges Wire and Cable Lines; Appointments. Operations of the wire and cable divisions of the apparatus and construction materials departments of General Electric have been recently consolidated, and all wire and cable business formerly assigned to the apparatus department at Schenectady, N. Y., has been transferred to the construction materials department at Bridgeport, Conn. B. F. Ilsley, formerly manager of the apparatus wire and cable division, has been named manager of the expanded division. Other appointments in the construction materials department include those of J. S. Overstreet, now manager of sales; R. P. Allison, manager of manufacturing; C. O. Hull, manager of Bridgeport engineering; V. A. Sheale, manager of Schenectady Engineering; E. N. Kimball, Jr., manager; T. R. Hancock, manager, marketing research division; J. E. Neuberger, operating manager, advertising division; H. Owen, manager of sales. At Syracuse, Robert E. Moe has been appointed division engineer for electronic receiving tube product lines of General Electric's tube divisions.

U. S. Steel Appointment. M. W. Reed, formerly chief engineer of the United States Steel Corporation of Delaware, has been appointed to the post of vice-president-engineering, to succeed B. H. Lawrence, who is retiring. Mr. Reed has served with subsidiaries of U. S. Steel since 1916.

Machlett Takes Over Western Electric Tube Manufacture. Machlett Laboratories, Inc., of Springdale, Conn. will soon take over the manufacture of the Western

(*Continued on page 20A*)



Transite Ducts installed in power station of the New York, New Haven and Hartford Railroad at Cos Cob, Connecticut.

These Transite Ducts safeguard Cos Cob's Power Lines

Transite* Ducts were chosen for the important job of protecting the power lines in the New Haven's Central Power Station at Cos Cob because they meet every requirement of a low-cost efficient cableway system.

These asbestos-cement ducts provide 5 major advantages:

1. Easy to Install—Transite Ducts are light in weight and come in long 10-foot lengths that are easy and economical to assemble and install.
2. Strong, Corrosion-Resistant—Transite is made of asbestos and cement combined under great pressure into a permanently strong structure. These ducts are practically unaffected by corrosive soils.
3. Immune to Electrolysis—Entirely inorganic and non-metallic, Transite Ducts are immune to electrolytic or galvanic action.
4. Permanently Smooth Bore—Long cable pulls and replacements are easy with Transite Ducts. Their smooth bore minimizes damage to cables.
5. Incombustible—Transite Ducts confine burnouts, protect adjacent cables in case of fire.

For further information on how Transite Ducts can increase the safety and cut the costs of cableway systems, write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville **TRANSITE DUCTS**

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(*Continued from page 16A*)

Electric Company's entire line of high power tubes for broadcast transmitters and allied applications. Machlett will manufacture the tubes for Western Electric to Bell Telephone Laboratories' designs.

S.R.I. Research Appointments. Thirteen new appointments augmenting the technical staffs of Southwest Research Institute and its sister organization, the Institute of Inventive Research, were announced recently. Appointed to the staff of the SRI, which conducts research for companies, individuals and trade associations on a fee basis at cost, were: C. E. Balleisen, Washington, D. C., mechanical research engineer; D. B. Crawford, Jeanette, Pa., gas research engineer; D. Hawley, Storrs, Conn., consultant on technical photography, electronics and instrumentation; M. Holland, New York, N. Y., industrial research consultant; L. H. Mayoral of Mexico, technical assistant in physics and mathematics; G. D. McCann, Pasadena, Calif., consultant on computer facilities; Apolonio L. Morales, Monterrey, Mexico, pharmaceutical and bacteriological technician; R. Neumann, San Antonio, Tex., director of public relations; N. C. Penfold, Chicago, Ill., assistant to the director, internal combustion engine research and fuel and lubricants research; K. Shaftan, Chicago, Ill., senior consultant in instrumentation; E. R. Strong, Jr., Chicago, Ill., technician in fuels technology; and J. S. Swearingen, chairman of engineering mechanics. The Institute of Inventive Research, which provides a complete processing service to inventors at no initial cost to them, has appointed Ion Edeleanu of New York, N. Y., as consultant on inventions and licensing.

Davidson to Direct B. F. Goodrich Research. Doctor William Lee Davidson, international authority on atomic energy, has been named director of The B. F. Goodrich Company's physical research department. Doctor Davidson, with B. F. Goodrich since 1940, worked at the government atomic energy project in Oak Ridge, Tennessee in 1947.

TRADE LITERATURE

Industrial Plant Distribution Systems. A 32-page booklet designed to assist electrical engineers and architects in their planning of adequate power distribution facilities to be installed in a new plant, or in the renovation of an old one. Published by the Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh, Pa., the booklet contains colored diagrams of 11 basic distribution systems, operating principles, photographs, and efficiency charts. Copies are available upon request to the company.

Galvanic Cell Corrosion. "Corrosion by Concentration Cells" issued by the International Nickel Company, contains information on corrosion phenomena acquired through applied research by INCO's corrosion engineering section. The booklet is complete in all engineering details, and includes drawings and other essential illustrative material. It is available without cost from the International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Thermocouple a-c and d-c Meters. Bulletin 502 published by the Rawson Electrical Instrument Company, Inc. of 105 Potter Street, Cambridge 42, Mass., gives complete data on Rawson portable Thermal meters and thermal multimeters with Vacuum thermocouples for the measurement of alternating or direct current. Copies are available by writing directly to the company.

Mechanical Differentials. "The Application of Small Mechanical Differentials to Instrument and Control Work" is a recent publication by the Milwaukee Lock and Manufacturing Company, manufacturers of a new line of small mechanical differentials in both open and jacket models. The manual contains information on the basic principals, measurement and control, speed, broad range infinite step transmission, and

(*Continued on page 28A*)

POWER AND LIGHT from 1 CIRCUIT

No need for an independently metered lighting system. Acme Electric Air Cooled Transformers connected to the power circuit provide lighting and appliance circuits at every location where they may be needed. Acme Air Cooled Transformers are All-Steel construction, no useless weight; designed for low temperature rise operation (only 55° C). 1/10 KVA to 50 KVA with primaries up to 600 volts. 1½ KVA to 25 KVA with 2400 volt primary. Bulletin AC160 gives complete details.

ACME ELECTRIC CORPORATION
223 WATER STREET CUBA, N. Y.

Acme ACME Electric

HOW LONG CAN A SKIRT BE?

Insulators with "skirts" present the ceramic engineer with some of his most difficult problems. Specifications on this one required a "skirt" depth of full 3/4". Meeting that specification in production quantities called for some very ingenious mold design. The result...a typical example of the experienced engineering and craftsmanship Universal applies to the solution of problems in porcelain insulation. If you have a design or production problem in porcelain insulation, Universal engineers will be glad to help you solve it.

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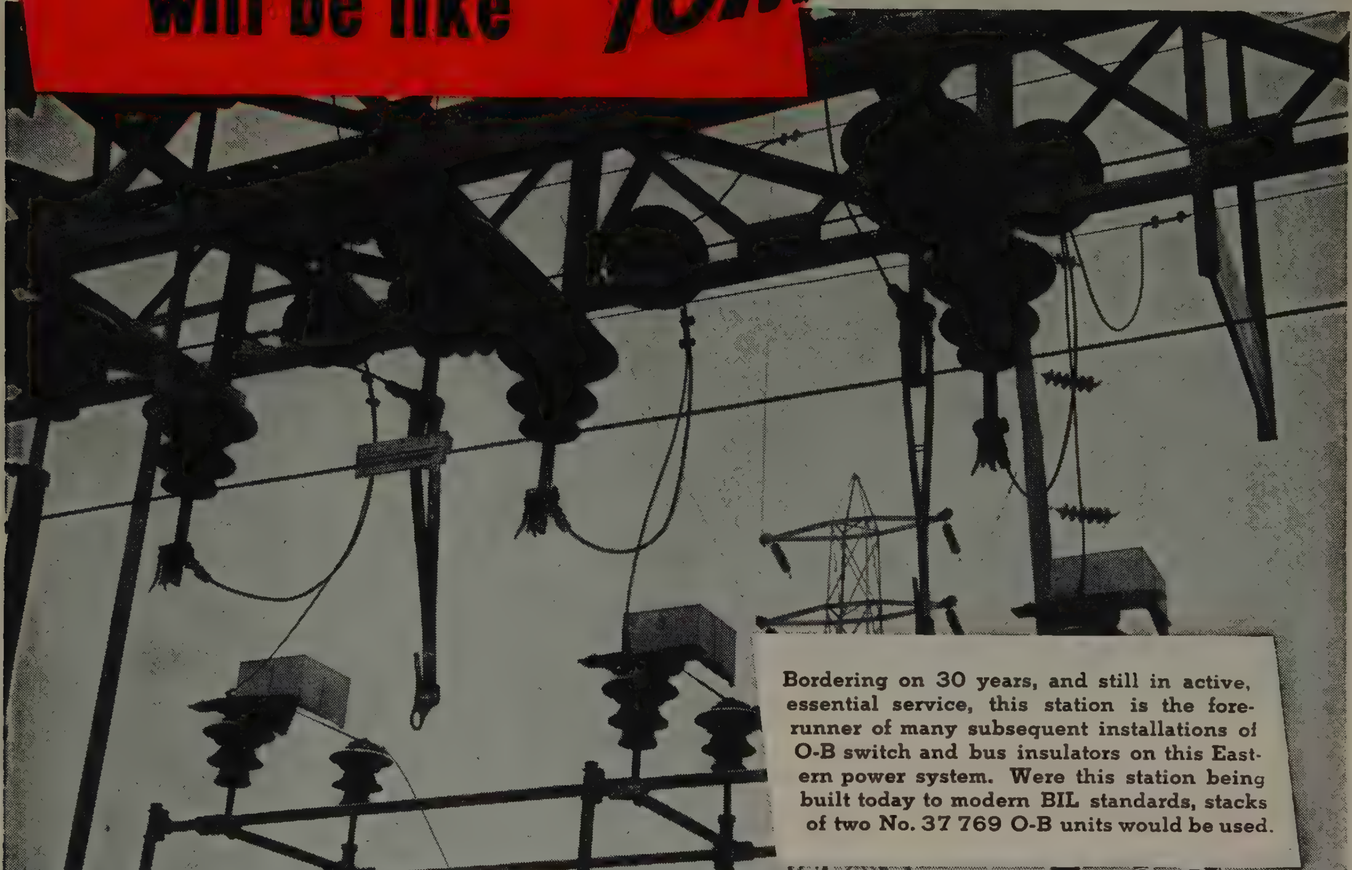
You can't specify what an insulator will be like TOMORROW!



Bordering on 30 years, and still in active, essential service, this station is the forerunner of many subsequent installations of O-B switch and bus insulators on this Eastern power system. Were this station being built today to modern BIL standards, stacks of two No. 37 769 O-B units would be used.

If you want to know how an insulator will be performing tomorrow, you must wait till tomorrow to find out! Specifications or standards don't cover this. They protect you only *today*. Your one safeguard for tomorrow is experience--experience that the manufacturer has *built into* the insulators; and experience that power companies have had *using them*. . . In the case of O-B switch and bus insulators, this experience goes back nearly thirty years in many instances, with the end no where in sight. Another fact: the great majority of O-B switch and bus insulator purchases are repeat orders *based on experience*. We know of no better proof of O-B durability--no better way of seeing into tomorrow when you buy insulators today

Ohio Brass

2867-H

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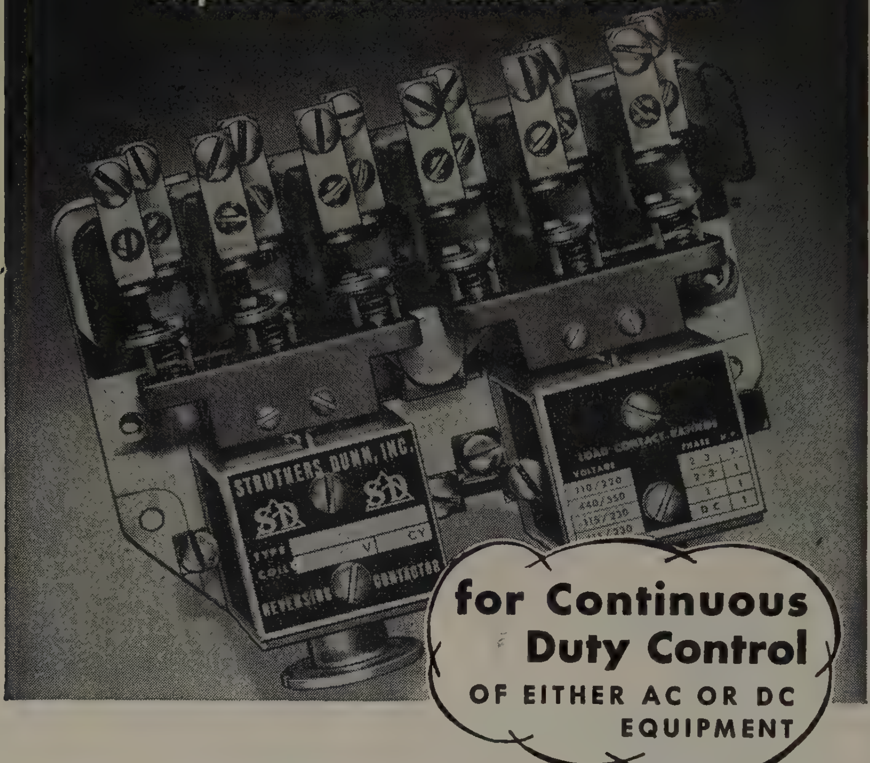

A "NEW" SMALL REVERSING CONTACTOR

. . . a result of three years experience in actual service

for Continuous Duty Control OF EITHER AC OR DC EQUIPMENT

Ideal for "Built-in" applications . . .

Completely serviceable from the front

THE FIRST small reversing contactor, introduced by Struthers-Dunn over 3 years ago, represented a big improvement over existing methods of controlling hoists, door operators and similar equipment. The design of this new contactor, Type 175KXX is based on broad experience in applying the original unit and incorporates still further advantages including greater ruggedness and the ability to withstand continuous service. Ratings are as follows:

AC single phase:	1 hp. 115 or 230 volts
AC polyphase:	2 hp. 110 or 220 volts 1 hp. 440 or 550 volts
Direct current:	1 hp. 115 or 230 volts

Two 3-pole solenoids, for forward and reverse operation, are mounted on a common frame and mechanically interlocked to prevent simultaneous closure. Contacts are completely insulated with melamine. Open arc chutes allow rapid cooling and escape of ionized gases.

Auxiliary contacts can be added for electric lock-up or interlock. All fixed contacts are interchangeable as are the moving contacts and corresponding parts on each solenoid. All parts are easily replaceable from the front.

Write for Data Bulletin 7100.

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(*Continued from page 20A*)

sequence controllers of mechanical differentials. For a copy of the manual, write to the company at 5046 North 37th Street, Milwaukee, Wis.

Allis-Chalmers Pamphlets. Allis-Chalmers, of Milwaukee, Wis., has issued three new booklets: "Allis-Chalmers Alternating-Current Across-the-line Motor Starters," Bulletin 14B7132; "Allis-Chalmers Engine-Type Synchronous Generators," Bulletin 15B6139A; and "Allis-Chalmers Switchgear and Control Devices," Bulletin 25B7095. All are available upon request to Allis-Chalmers Manufacturing Co., S. 70th St., Milwaukee, Wis.

GE Booklets. An 80-page illustrated booklet containing detailed information, prices, and ASA accuracy classifications on 107 types of standard instrument transformers manufactured by General Electric is available. GE has also issued another booklet, "Electric Connectors," which describes a complete new line of solderless electric connectors, featuring serrated, silver contact surfaces, interlocking sides, and which will accommodate a wide range of conductor sizes. Address requests to the General Electric Company, Schenectady 5, N.Y.

"Megger" Insulation Testers. Bulletin 21-20-7, issued by the James G. Biddle Company, simplifies the selection of hand-driven, motor driven, and multi-voltage instruments for specific insulation resistance measuring problems. Complete specifications, special features, ranges and applications are also included. For a copy of the booklet, write to James G. Biddle Company, 1316 Arch Street, Philadelphia 7, Pa.

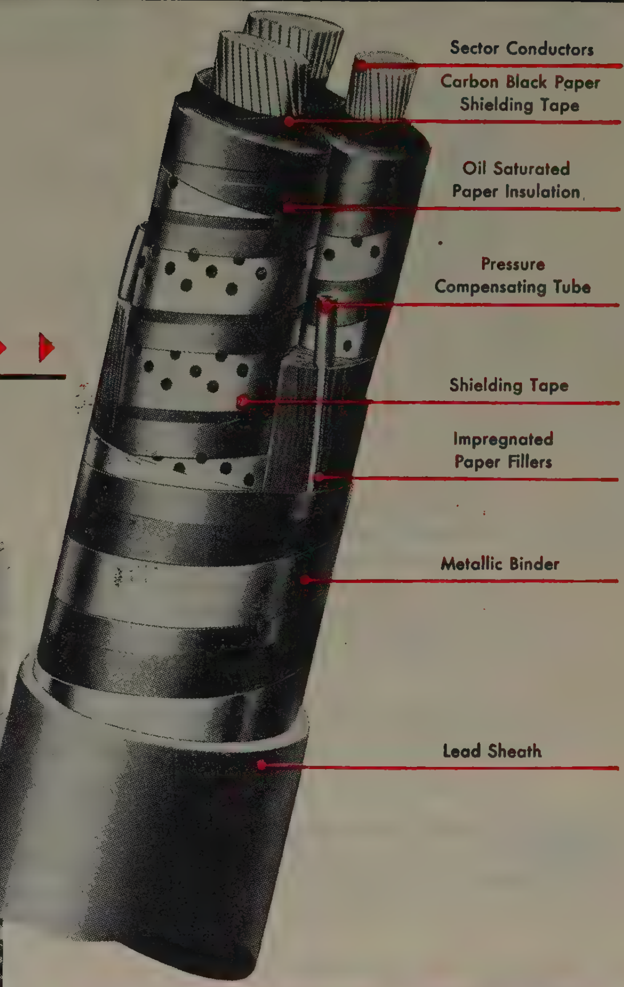
V-Belt Manual. The mechanical goods division of United States Rubber Company, at Rockefeller Center, New York 20, New York, has recently published a 100-page manual to assist engineers in designing both multiple and light duty belt drives. The booklet contains an extensive set of drive tables for multiple belts; complete construction dimension and weight data; fractional horsepower drive layouts; and information on quarter-turn drives and hexagon double V-drives. Copies may be obtained by writing to the company.

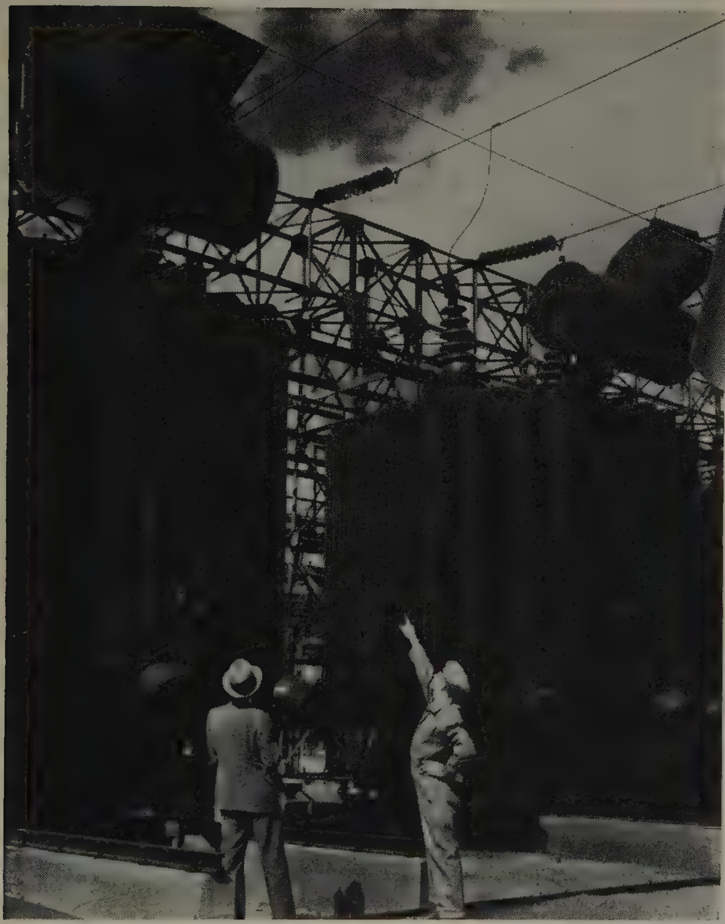
Magnetic Amplifier Bulletin. A new 32-page magnetic amplifier bulletin VT-2000 which describes circuits, characteristics and applications of the Vickers Magnetic Amplifier is available upon request from Vickers Electric Division, Vickers, Inc., 1815 Locust Street, St. Louis 3, Mo.

Solenoid Information. G. H. Leland, Inc. of Dayton 2, Ohio, has issued a booklet containing the basic engineering data on the Ledex rotary solenoid, which is now being used in all sorts of new, remote-controlled devices. The complete line of Ledex rotary solenoids, along with their

(*Continued on page 32A*)

the heat is on
PAPER CABLE . . . .
like a transformer


Sector Conductors
Carbon Black Paper Shielding Tape
Oil Saturated Paper Insulation
Pressure Compensating Tube
Shielding Tape
Impregnated Paper Fillers
Metallic Binder
Lead Sheath



Power transformer with inert gas seal for controlling internal pressure without exposing cooling oil to the atmosphere.

ADVANTAGES OF GPC "GAS PRESSURE COMPENSATED" CABLE

1. Insulation maintained thoroughly saturated with compound at all times.
2. Internal pressure is stabilized within prescribed limits.
3. Controlled sheath stresses. There is no repeated expansion and contraction, no fatigue or splitting of lead.
4. Pressure along cable line is uniform, not variable from joint to center of section to joint.
5. Interchangeability. Cable can be spliced to existing solid type cable without difficulty.
6. Increased current carrying capacity. Many present-day limits are based on allowable sheath stress. Type GPC Cable controls these stresses.
7. Improvement in operating voltage stress is possible, since ionization and gas inclusions are eliminated.
8. Reduced over-all transmission cost per KVA mile.
9. Continuous sheath supervision.

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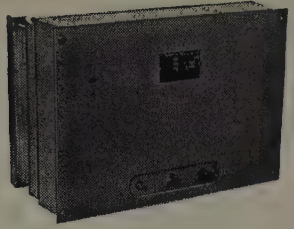


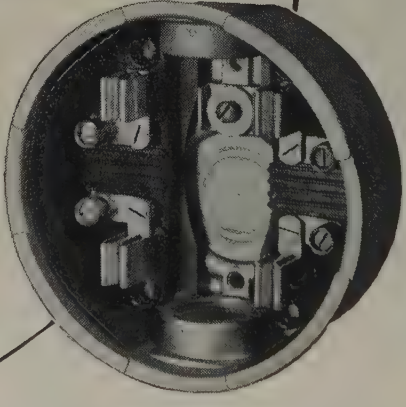
the first line of standard electronic voltage regulators

Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under SIMULTANEOUS line and load changes.
SIX IMPORTANT SORENSEN FEATURES:

1. Precise regulation accuracy;
2. Excellent wave form;
3. Output regulation over wide input voltage range;
4. Fast recovery time;
5. Adjustable output voltage, that once set, remains constant;
6. Insensitivity to line frequency fluctuations between 50 and 60 cycles.

The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

SORENSEN and company, inc.
375 fairfield avenue, stamford, connecticut



standardized deep meter socket

FEWER ITEMS TO STOCK!
EASIER INSTALLATION!

LOW PRICE *PLUS*

1. Additional wiring space for more liberally rated conductors
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3. Bonderized plus baked-on aluminum paint for increased corrosion resistance and longer life
4. Base is die-cast for strength and permanency of dimensions
5. One-piece snap-action stainless-steel ring. No tools required for installing this quick-hitch ring.

● This new four-terminal standardized socket, Type R-1, covers with one catalog item the widest practicable range of applications and ratings for single-phase metering. It reduces the number of items to be stocked, increases interchangeability, and provides for future growth.

Detailed specifications and installation suggestions are available from your nearest G-E representative. Consult him today, or write for Bulletin GEA-5147. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC
601-43

(Continued from page 30A)

various modifications and extra features are presented in this booklet, including dimensional data, electrical characteristics regarding torque, temperature rise, and duty cycle. Copies are available upon request to the company.

NEW PRODUCTS ••

"HiperCore" Distribution Transformer. A new "HiperCore" transformer is being produced by the Moloney Electric Company, in both conventional and *CSP* types. Wound cores, of high-permeability oriented silicon steel, having a 30 to 35 per cent greater flux carrying capacity are used, which results in an up to 30 per cent decrease in the weight and size of the transformer. The new transformers also have improved short-time overload characteristics, providing peak load performance and longer life, reduced coil mass, and the extensive use of coiling ducts. They are available in sizes of 50 kva and smaller, in voltage classes of 15 kv and lower. For further information, write the Moloney Electric Company, St. Louis 20, Mo.

Servo Analyzer. The Flight Research Engineering Corporation has introduced a new general purpose servomechanism and automatic control system test instrument, called the "Servo Analyzer—Type 5." The instrument may be used to measure the dynamic response of servos, amplifiers, or networks which use either d-c or 400-cycle a-c error measuring devices. It is suitable for testing servos whose resonant frequencies are in a range between 1/10 and 60 cycles per second. When connected to a servo system under test, the analyzer provides data which otherwise could be obtained only by lengthy computation. Further information may be obtained by writing to the Flight Research Engineering Corporation at Richmond, Va.

IRC Resistor. A new insulated fixed composition resistor has been produced by the engineering and research departments of International Resistance Company. Designated as Advanced Type *BT*, the resistor is being produced in 1/3, 1/2, 1, and 2-watt ratings—equivalent to *JAN* types, *RC10*, *RC20*, *RC30*, and *RC41*. It meets joint Army-Navy requirements under *JAN-R-11* specifications. The type *BTR* resistor body measures 3/32 inch × 13/32 inch, and is furnished in ±5, 10, and 20 per cent tolerances in Radio Manufacturers Association resistance ranges. Temperature coefficient varies from 2 to 14 per cent per degree centigrade. Voltage varies between zero and 27 per cent per volt. For short periods, overloads of 50 per cent to 100 may be applied without damage to the Advanced *BT*, and 5 second overloads of 2.5 time rated load result in negligible resistance changes. Write for Technical Bulletin B-1, the International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa.

HIGHLIGHTS........

AIEE Conferences. The popularity of the technical conference type of meetings where a limited field is explored thoroughly seems to be growing. Four of these gatherings have been scheduled for the next few months. Programs for the AIEE conference on industrial application of electron tubes (*pages 349–50*), the AIEE conference on rubber and plastics industries (*page 352*), and the AIEE conference on the textile industry (*pages 352–3*) appear in this issue. The program of the AIEE conference on materials handling (*page 353*) is scheduled for the May issue.

South West District Meeting. "What Electrical Engineers Are Doing to Meet the needs of the Growing Southwest," is the theme of the AIEE South West District meeting which is being held in Dallas, Tex., April 19–21, 1949. The tentative program for this meeting appears in this issue (*pages 350–1*).

AIEE PROCEEDINGS. A new AIEE *PROCEEDINGS* order form which lists those winter meeting technical program papers that will be included eventually in AIEE *TRANSACTIONS* appears in the advertising pages of this issue (*pages 25A–26A*). Order forms already published that are still being accepted are listed elsewhere on this page.

Winter Meeting Report. The remainder of the winter general meeting news report appears in this issue (*pages 354–61*). Quite a number of conference papers were featured at this meeting. Brief authors' digests of most of these also are included in this issue (*pages 328–46*).

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Modern Automatic Irons. The modern automatic iron combines both the latest technical developments and up-to-the-minute styling. This is a far cry from the first electric irons of 50 years ago which were little more than old-fashioned top-of-the-stove irons with a heating element and cord added (*pages 303–07*).

Television Receivers. Ten million television receivers will be in use by the end of the next five years. This article covers the amount and nature of the load required by these television receivers. As pointed out, this increased load should be most welcome to an expanding electric power industry (*pages 291–3*).

Transporting Natural Gas. One billion kilowatt-hours are consumed yearly by the "Big and Little Big Inch" gas lines, which transport natural gas from Texas and Louisana to New York and New Jersey. These line were built during the war to carry crude oil and refined petroleum products. Plans and methods of converting the equipment and lines are described in this article (*pages 295–301*).

Electro-optical Shutter. Components of the electro-optical camera, which uses a Kerr cell as a shutter, are described in detail. A photographic record of the electrical vaporization of a fine wire taken with an effective exposure time of 0.000,000,04 second is shown. Comments are made on the ultimate possibilities and future applications of the shutters for ultra-high-speed photography (*pages 282–8*).

Electronic Digital Counters. The ability to count individual items at the rate of a million or more per second has been achieved through the application of electronic circuits in this field. Their tremendous speed more than makes up for their complicated systems. The counters, which have many purposes in large computers, are explained in detail (*pages 309–14*).

Co-operative Education. The first purpose of the co-operative plan of education is "to benefit the individual student directly by providing for him in industry an essential educative opportunity unavailable in a campus-confined curriculum." A description of the plan as it operates at the undergraduate level is presented by a professor of electrical engineering (*pages 279–81*).

AIEE PROCEEDINGS

Order forms for current AIEE *PROCEEDINGS* have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of AIEE *PROCEEDINGS* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *TRANSACTIONS.*

AIEE *PROCEEDINGS* are an interim membership service, issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec '46, pp 567–8; Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *PROCEEDINGS* will appear in *ELECTRICAL ENGINEERING* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter general (1948)
Aug '48, p 45A	Great Lakes District North Eastern District Summer general
Oct '48, p 43A	Pacific general Middle Eastern District
Dec '48, p 35A	Midwest general Southern District
Apr '49, p 25A	Winter general (1949)

Direct Lightning Strokes. A discussion on transmission line design and performance based on direct lightning strokes is presented in this article. Curves, based on stroke current probability data and taking into account line parameters, are included (*pages 317–24*).

Transistor Credit Due. Because of an inadvertence in the recasting and proofreading of the article, "The Transistor—A New Semiconductor Amplifier," (*EE, Mar '49, pp 215-21*) W. G. Pfann and R. J. Kircher failed to receive credit for their contributions to the development of these devices. The authors wish to point out that the design and processing of the type *A* transistor follow closely those of an earlier model which was developed by Pfann. This model subsequently was modified by Kircher to adopt it to the present socketing scheme.

Misprint. A correction is in order in the third line of the caption to Figure 2 which appeared with the digest, "A 24,000-Rpm Alternator for Aircraft," by T. J. Martin (*EE, Mar '49, p 243*). A misplaced decimal makes the alternator 6.25 kva. It should have appeared, of course, correctly as 62.5 kva.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50, Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. April 1949, Vol. 68, No. . Number of copies of this issue 52,100.

Imcor Glass Tapes take many of the "ifs" out of electrical construction—by *protecting* your units against:

EXCESSIVE MOISTURE—will not swell or disintegrate from contact with moisture. Glass fibers are nonabsorbent.

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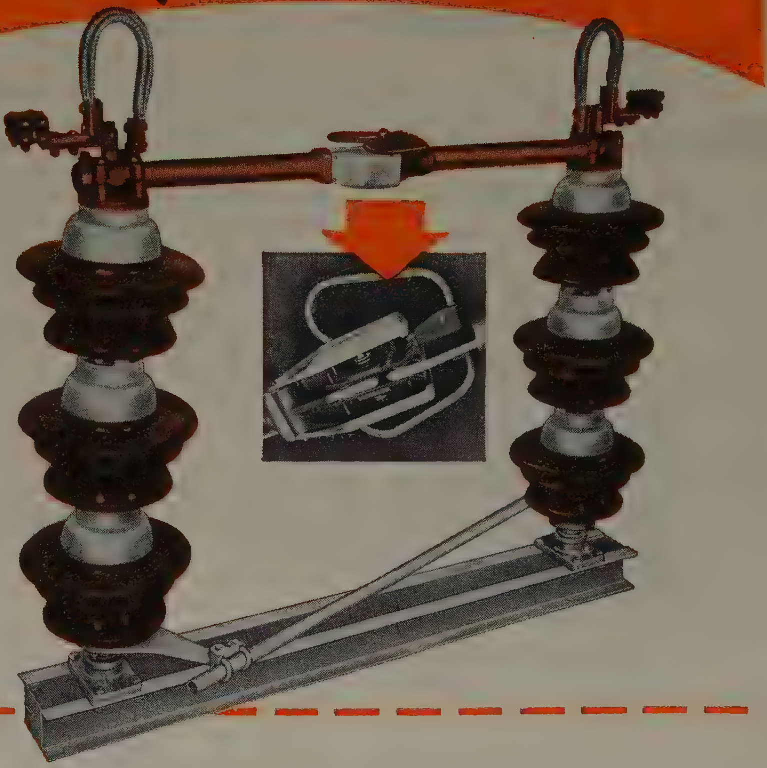
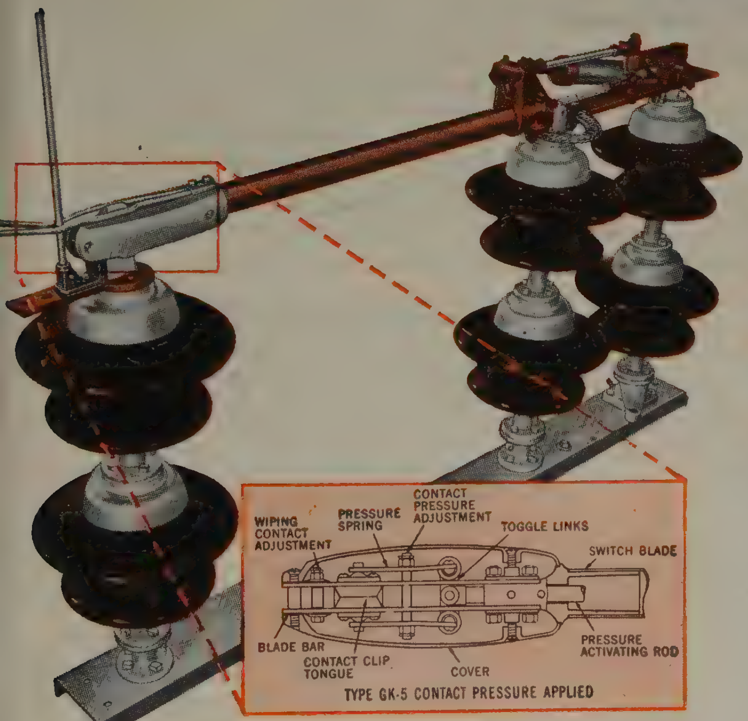


TYPE XX—Center Break 7.5 through 230 Kv.

Designed primarily for use on installations where phase spacing or operating room is limited.

- **EASILY OPERATED . . .** Insulator stacks, driven by crank and link mechanism, rotate in opposite directions to open the switch with a shearing action that easily breaks ice accumulations.
- **SILVER-INLAID, PROTECTED CONTACTS . . .** Non-ferrous housing provides corona shielding and sleet protection for contacts. Heavily silver-plated blade produces low resistance contact. Contact springs, out of current path, maintain positive pressure.

Type XX Switches are made in standard voltage ranges from 7.5 through 230 Kv., 400 through 1200 Amps.



TYPE GK-5 CONTACT PRESSURE APPLIED

TYPE GK-5

For Sub-Station and Line Disconnect Service up to 287 Kv.

- **LARGE AREA CONTACTS** provide maximum thermal capacity.
- **SILVER CONTACT SURFACES** maintain lower contact resistance by preventing copper oxidation.
- **CONTACTS WIPE CLEAN WITHOUT ABRASION . . .** Blade and clip contacts engage with gentle wiping action that cleans surfaces without abrasion.
- **HIGH CONTACT PRESSURE APPLIED AFTER CLOSING . . .** High pressure is attained between blade and clip by the final movement of operating mechanism. This pressure is attained without abrasive movement between blade and clip contact surfaces. Contact pressure is released *before* blade moves in opening operation.

Diagram shows Type GK-5 contact mechanism. After closing motion is completed, cam-actuated control rod causes toggle links to expand against the leaf springs and transmit high pressure to the contact surfaces.

RIGHT when you specify

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ELECTRICAL TRANSMISSION & DISTRIBUTION EQUIPMENT
FOR CONSTRUCTION, MAINTENANCE & OPERATION
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Silicone News

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100% more pull per unit size

We're dependent upon mechanical muscles in the form of solenoids activated by automatic or finger-tip control. But there's a limit to the amount of work even mechanical muscles can do. That limit is set by restrictions on size or weight and by the heat stability of the insulating materials used in winding the coil.

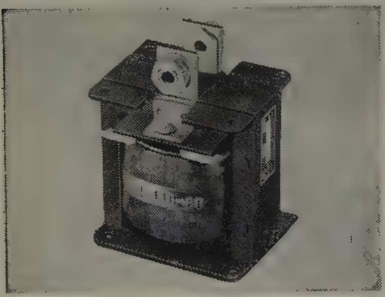

PHOTO COURTESY B/W CONTROLLER CORPORATION

Silicone insulated "Hi-Power" small space solenoids operate continuously in either 25 cycle 110 to 220 volt or 60 cycle 110 to 550 volt service.

Use of heat-stable Silicone Insulation has enabled engineers at B/W Controller Corporation of Birmingham, Michigan, to give you almost twice as much power without increasing the size or weight of their small space solenoids. For example, the new B/W "Hi-Power" solenoid has a push or pull of 32 pounds at 100% voltage compared with 17-18 pounds for a comparable Class "A" solenoid.

This increase in power per unit size is made possible by the exceptional heat stability of Dow Corning Silicone Insulation. This new class of electrical insulation gives long and continuous service at temperatures in the range of 200-260° C. "Hi-Power" solenoids operate continuously in 25 cycle 110 or 220 volts as well as in 60 cycle service up to 550 volts. DC Silicone Insulation also assures efficient operation in spite of high ambient temperatures.

And Dow Corning Silicone electrical insulation gives you more power per pound in other kinds of electrical equipment including motors, transformers, and generators. For more information, call our nearest branch office or write for our new collection of case histories on Silicone Insulation, pamphlet No. G7-A-2.

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FIRST IN SILICONES

INDUSTRIAL NOTES ....

Westinghouse Atomic Division Appointments. William E. Shoupp, distinguished nuclear physicist, recently was named director of research for the Westinghouse Electric Corporation's new Atomic Power Division, and Robert A. Bowman, engineer, was named manager of engineering. Both men will help guide the division's activities, which will include construction and testing of an atomic power plant for the propulsion of naval vessels. Under the contract recently awarded to Westinghouse by the Atomic Energy Commission, a nuclear reactor for shipboard use will be engineered in the Pittsburgh area.

Arthur D. Little Elections. Professor Thomas K. Sherwood, dean of engineering of Massachusetts Institute of Technology, and Doctor Bruce S. Old, staff member of Arthur D. Little, Inc., Cambridge, Mass., were elected to the board of directors of that company, which is a research and engineering organization. In his report to stockholders, Earl P. Stevenson, president of Arthur D. Little, stated that the volume of research and engineering projects conducted for clients in 1948 reached a new high level. He also reported that additional blast furnaces were converted during 1948 to high top pressure operation, a technique which his company is licensing to the steel industry. One steel company has reported that because of conversions to pressure operation its pig iron capacity was increased by 180,000 per year in 1947 and 1948.

S and C Appointment. The S and C Electric Company has announced the appointment of Lawrence M. Rudbeck as sales engineer for the Indiana, Western Kentucky, Southern Illinois territory, with headquarters at 310 Test Building, 54 Memorial Circle, Indianapolis 4, Ind.

Dedrick Joins Sylvania Research Staff. Doctor J. R. Dedrick, formerly associate professor of powder metallurgy at the University of Cincinnati, has been appointed section head of the advanced development group at the metallurgical research laboratories of Sylvania Electric Products, Inc.

Indiana Steel Promotion. Robert F. Smith, vice-president and sales manager of The Indiana Steel Products Company, Chicago, Ill., has been appointed to the newly created post of vice-president and general manager. Smith's previous post will be filled by Frank A. Hayden, formerly eastern sales manager of the company.

Cornell-Dubilier Sales Appointments. Paul H. Burgage, Jr., formerly purchasing agent for the Cornell-Dubilier Electric Corporation of South Plainfield, N. J., has been advanced to the post of director of purchases. The position includes supervision of purchasing in all six Cornell-Dubilier plants. Other appointments are those of Alfred S. Gartner as assistant to Arthur Williams, sales manager of the capacitor manufacturing division, Charles H. Caine, now vice-president of the new Cornell-Dubilier midwest direct factory sales office at 605 North Washington Avenue, Chicago, Ill., and Vernon C. Macnabb, who will represent the company in Michigan.

G-E News. General Electric Company recently opened a new and greatly expanded apparatus service shop in Seattle. It is one of the most modern in the company's cross-country chain of 29 service shops, and has been staffed and designed to give round-the-clock service every day of the year to users of motors, turbines, generators, controls, and other electric apparatus. At Schenectady, E. D. McArthur has been appointed head of GE's research laboratory's high-frequency electronics division; at Bridgeport, Lewis R. Mellem has been named acting commercial engineer of the GE range and water heater division; at Montreal, Quebec, Canada, it was announced that in order to avoid confusion among medical and industrial users of X-ray, the name of the Victor X-ray Corporation of Canada, Ltd., has been changed to General Electric X-Ray Corporation Limited, paralleling the name of its United States affiliate.

New W. N. Matthews plant. The W. N. Matthews Corporation of St. Louis, Mo., manufacturers of electric distribution equipment, have completed and now are occupying their new plant and offices at 3850 Delor Street. It is expected that due to the addition of new machinery, and the resulting greater efficiency in handling materials, production definitely will increase.

Safety Equipment Laboratory. Research and development of safety equipment for all industries, including the electrical industry, will be undertaken in a new laboratory, the largest of its kind, to be built at Pittsburgh by the Mine Safety Appliances Company. George H. Deike, president, explained that activities of scientists there will be co-ordinated with those of the United States Bureau of Mines, United States Public Health Service, Industrial Hygiene Foundation of Mellon Institute, Harvard School of Public Health, the new School of Public Health at the University of Pittsburgh, and fellowships at other leading universities.

U. S. Rubber Appointments. Frederick P. Combier has been named sales manager and Robert C. Cassidy chief engineer for Uskon electric heating panels, a product of the wire and cable department, United States Rubber Company. Uskon is a new method of home radiant heating employing conductive rubber panels in the ceiling.

(*Continued on page 20A*)

Proudly Announces

The FIRST NEOPRENE-JACKETED SERVICE ENTRANCE CABLE

Accepted by UNDERWRITERS' LABORATORIES* and with Laytex® Insulation

You've never seen a service entrance cable like this! Neither had Underwriters' Laboratories.

This great new U. S. Product answers the demand for a cable that will *not* festoon.

Underwriters' put the cable through a rough series of tests. Here are the results:

Dripping of compound at high temperatures: None.

Bending at low temperature: No damage sustained.

Flame Test: No burning of the paper indicator, nor any persistence of flame after last application of the test flame.

NOMINAL DIMENSIONS		
SIZE	NEOP. JACKETED	STD. BRAID
3#6	.47 x .74	.56 x .86
2#6 & 1#8	.45 x .73	.55 x .85
3#8	.38 x .62	.50 x .76

Note smaller diameter of this new cable, compared to diameter of standard braid.

High Current Test: Cable did not flame, rupture, nor warp excessively.

Di-electric strength: No electrical breakdown as a result of this test.

Conductor Pull-Out tests: Using 3 different connectors, the U. S. Cable *held 3 times better* than standard design cables.

Rough Handling at Low Temperatures: A coil of the new cable was wrapped as if for shipment and then exposed for 5 hours to a temperature of minus 34.4 C. It was then dropped 8 feet to a concrete floor. There were no breaks or cracks in the Neoprene sheath as a result of this test.

Abrasion: In testing the abrasion resistance of the outer covering, the New U. S. Cable proved to be over 10 times more resistant than that of conventional design.

Send today for information on this great new cable. Electrical Wire and Cable Department, United States Rubber Company, 1230 Avenue of the Americas, New York 20, N. Y.

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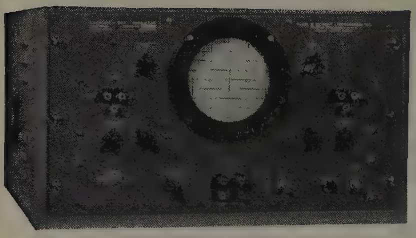
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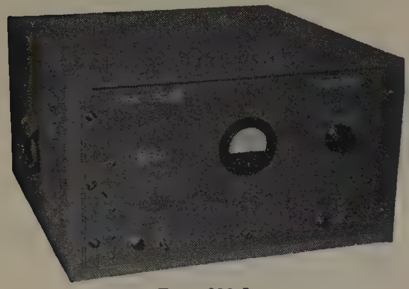
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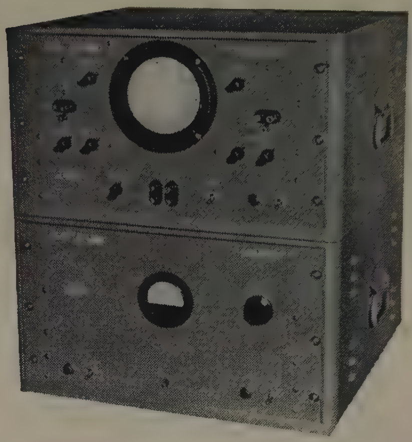
A packaged combination.

★ Here's why: For your cathode-ray indicator needs you have available, for example, the extremely useful Du Mont Type 281-A. This basic cathode-ray instrument is adaptable to almost any application because it permits a choice of time bases from any external source—linear, logarithmic; driven, recurrent. Also, the brilliant traces of its Du Mont Type 5RP-A Cathode-ray Tube make it capable of displaying the fast writing rates of single transients.

The utility of the Type 281-A may be still further extended by the availability of external power supplies, such as the Du Mont Type 286-A, for examining extremely high writing rates. By increasing the accelerating potential to 29,000 volts, the Type 281-A becomes what is probably the fastest writing and brightest cathode-ray instrument in the world. Writing rates in excess of 400 inches per microsecond are then available!

A further advantage: all of the usefulness of permanent records can be obtained with oscillograph-record cameras such as the Du Mont Type 314-A or 271-A, both of which are specifically designed for the purpose.

This varied combination of Du Mont equipment is illustrative of the full line of Du Mont instruments and tubes—including dual-beam oscillographs, wide-band oscillographs, polar-coordinate indicators, power supplies, accessories—at prices from one-hundred to five-thousand dollars. And always a wise, lasting investment when you begin with a Du Mont instrument or tube!

DETAILED LITERATURE ON REQUEST: EQUIPMENT DEMONSTRATED. NO OBLIGATION.

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y. U. S. A.

(Continued from page 16A)

New Publishing Company. The Newton Publishing Corporation, sole agent in the United States for the Swiss Publishing House, Verlag Birkauser, Basle, has been established at 114 East 32d Street, New York 16, N. Y. Books already available represent the latest scientific and technical works in German, written by the leading scientists in Europe, as well as many of the most important scientific periodicals published in Europe today, such as "Experientia," and "Elemente der Mathematik."

Allis-Chalmers Appointments. New appointments in the Allis-Chalmers steam turbine department are C. A. Robertson, engineer in charge of test and engineering calculations groups, engineering section, and W. F. Dueringer, supervisor of service engineering, sales section.

A. F. Metz Elected Okonite's President. Albert F. Metz was elected president and general manager of The Okonite Company, Passaic, N. J., at a recent board of directors' meeting. Metz, formerly vice-president and treasurer, replaces Frank C. Jones, who died in January. The board also elected Stephen A. Wilson, the company's general counsel, as a director, and Donald R. Stevens as executive vice-president, and a member of the executive committee.

Westinghouse Appointment. Westinghouse Electric Corporation has appointed C. H. Bartlett as manager of power transformer sales of the Westinghouse Transformer Division at Sharon, Pa. Bartlett will supervise sales activities of power transformer 501 kva and above, converter, rectifier, regulating and grounding transformers, and current limiting reactors for his division.

Audio Development Staff Addition. Robert M. Hanson has been assigned to the engineering staff of the Audio Development Company, of Minneapolis, Minn., in the position of chief engineer.

$3,000,000 Goodrich Plant. First unit of the new $3,000,000 general chemicals manufacturing plant of B. F. Goodrich Chemical Company, at Avon Lake, Ohio, is scheduled to start operations in the second quarter of 1949. New plasticizers for vinyl and synthetic resins will be the first products made in the plant, which will produce a number of general chemicals.

Eastman Kodak Promotions. William A. Hallett has been made assistant superintendent of the engineering and maintenance shops of the Eastman Kodak Company, at Kodak Park, Rochester, N. Y., and Walter C. Strakosh assistant superintendent of the engineering and maintenance planning department.

Electric Trolley Production Reaches Peak. According to an industry survey published in the annual review edition of *Bus Transportation* magazine, the electric

(Continued on page 28A)

Resistors Illustrated Are Grade 1, Class I, Characteristic "F"

OHMITE JAN TYPE WIRE-WOUND RESISTORS

MEET REQUIREMENTS OF JOINT ARMY-NAVY SPECIFICATION JAN-R-26

TYPES AND SIZES

TAB-TERMINAL TYPE

	Overall length	Diameter	*Watts
RW-30	1"	19/32"	8
RW-31	1½"	19/32"	10
RW-32	2"	19/32"	12
RW-33	3"	19/32"	18
RW-34	3"	29/32"	30

	Overall length	Diameter	*Watts
RW-35	4"	29/32"	38
RW-36	4"	1-5/16"	60
RW-37	6"	1-5/16"	70
RW-38	8"	1-5/16"	110
RW-39	12"	1-5/16"	166

TAB-TERMINAL TYPE with terminal hole to clear No. 8 screw

	Overall length	Diameter	*Watts
RW-40	3"	29/32"	24
RW-41	4"	29/32"	32
RW-42	4"	1-5/16"	49
RW-43	6"	1-5/16"	74
RW-44	8"	1-5/16"	100
RW-45	12"	1-5/16"	160

FERRULE-TERMINAL TYPE

	Overall length	Diameter	*Watts
RW-10	11-7/16"	1-5/16"	140
RW-11	9-5/8"	1-5/16"	116
RW-12	7-7/16"	1-5/16"	86
RW-13	5-1/8"	1-1/16"	50
RW-14	4-7/16"	1-1/16"	40
RW-15	2-15/16"	3/4"	20
RW-16	2-3/8"	3/4"	14

*Watts free air, JAN Characteristic "F"

To qualify for approval under Joint Army-Navy characteristics, resistors are required to withstand in excess of nine cycles of immersion in saltwater baths of 100°C and 0°C; to withstand a severe vibration test for five hours; and, in addition, are subjected to all other tests as specified in JAN-R-26. Ohmite Resistors designed for JAN-R-26 are specially vitreous enameled and have a textured gray finish. Available in the types and sizes listed.

Write on Letterhead for Bulletin No. 139

OHMITE MFG. COMPANY
4802 Flournoy St., Chicago 44, Ill.

Be Right with...

OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

(*Continued from page 20A*)

trolley coach industry in 1948 topped all previous production figures by delivering to operating companies 1,426 vehicles. As a result of this record delivery, there are now 5,698 trolley coaches in operation in 66 United States cities.

Ohio Brass Elections. At the recent directors' meetings of The Ohio Brass Company of Mansfield, Ohio, W. A. Springer was elected vice-president and treasurer, and Ephraim H. Brown was elected secretary. All other officers were re-elected. It was also announced that Louis J. Ott had been appointed general sales manager, and R. A. LeFevre advertising manager.

NEW PRODUCTS ••

Aluminum Counter Tube. Radio Manufacturers Association type designation *1B85* has been assigned to the new aluminum beta-gamma counter tube designated by The Victoreen Instrument Company to replace the thin-walled glass tubes previously used in laboratory and field radiation measuring instruments. The Thyrode *1B85* operates at 900 volts, plateau length is not less than 200 volts and the plateau slope does not exceed three per cent per 100 volts. Nominal recovery time is 100 microseconds; minimum operating life is 10^8 counts with life test end point plateau 850 to 950 volts. For further information, write to The Victoreen Instrument Company, 5806 Hough Avenue, Cleveland 3, Ohio.

Electrical Operation Checker. Operation of electrical components at rated, under, and over voltage may be checked rapidly with a recently developed test instrument manufactured by Eastern Transformer Company, 147 West 22d Street, New York 11, N. Y. Two controls are provided in the instrument; one adjusts the output to the nominal voltage required for the test, the other adjusts the output to the required under or over voltage. Eleven nominal voltages are available. Each unit is made to the customer's specifications. Nominal output voltages which are available are 110, 208, 220, 380, 440, and 550 volts, and any of these voltages may be varied 10 or 20 per cent over or under nominal voltage. Further information may be obtained by writing directly to the Eastern Transformer Company.

General Electric Developments. A new 7-pin miniature electronic tube type *GL-5610*, now is being manufactured by the General Electric Company. Under maximum ratings, the plate voltage of the *GL-5610* is 300 volts, with a place dissipation of three watts. Operation characteristics include heater voltage, 6.3 volts; plate current, 17 milliamperes; and plate resistance, 3,500 ohms. Further information is available from the Tube Divisions, General Electric Company, Schenectady, N. Y. Another recent development at GE is a new 3-kilovar secondary capacitor, designed for use on 240-volt house feeder circuits where the use of such devices previously could not be justified for economic reasons. Priced at approximately 60 per cent of the price per kilovar of the previously available 240-volt capacitors, the new capacitor is a complete redesign of existing models. Rated at 240 volts, single phase, 60 cycles, it features a hermetically sealed aluminum alloy case which has two stud-type porcelain bushings. Small, and light in weight, the unit is designed for on the pole mounting. Manufactured only in the 3-kilovar size but additional units can be added if more than that capacity is required at any one location. Additional information is available by writing to General Electric Company, Schenectady 5, N. Y. General Electric also recently brought out a new luminaire equipped with a built-in photoelectric control which responds to changes in the prevailing light level and turns the lamp on and off as conditions of visibility demand. The Form 110 luminaire has a standard optical system and mountings,

(*Continued on page 32A*)

SAFE!

AT 15,000 VOLTS

This insulator, designed for use in luminous tube sign work, carries a secondary of 15,000 volts with assured safety. Further, it will not carbonize nor corrode under long years of service and is unaffected by heat, cold, fumes, moisture and most acids. Designing and producing tough, sturdy insulators with high efficiency factors is the every-day job of Universal engineers and craftsmen. If your insulator requirements involve special designs or specifications, a Universal engineer will be glad to assist you. No obligation, of course.

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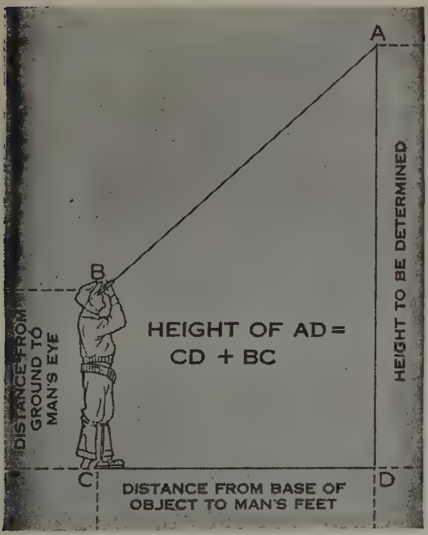
A
B
C
D
DISTANCE FROM GROUND TO MAN'S EYE
HEIGHT OF AD = CD + BC
HEIGHT TO BE DETERMINED
DISTANCE FROM BASE OF OBJECT TO MAN'S FEET

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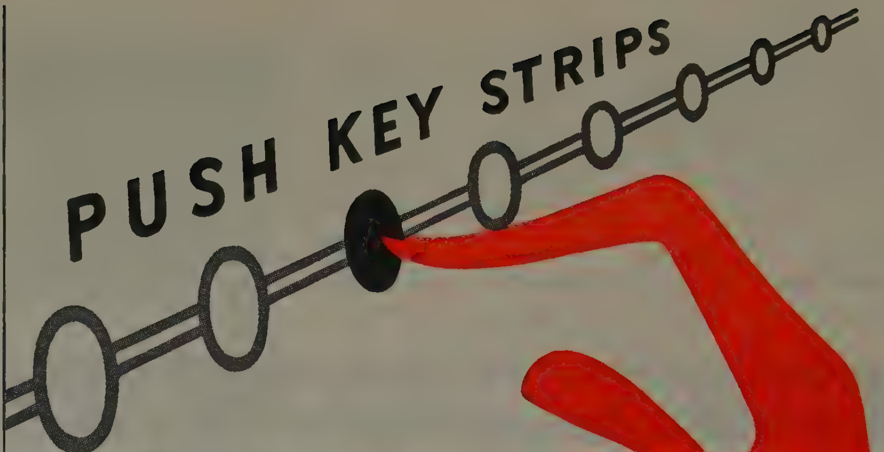
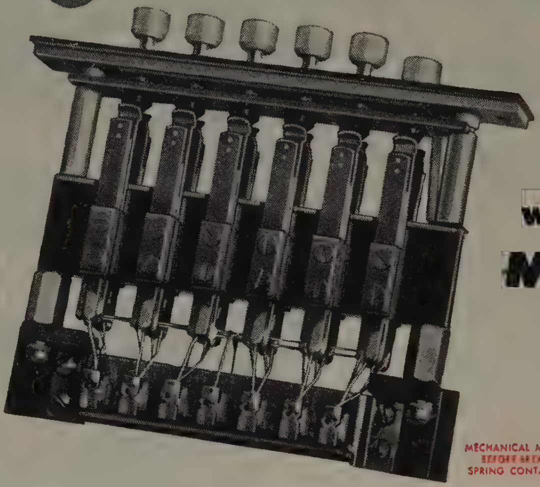
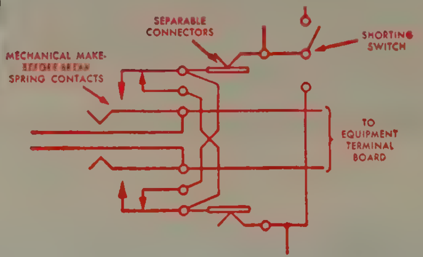
PUSH KEY STRIPS



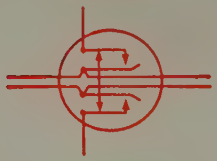


with POSITIVE MECHANICAL INTERLOCK

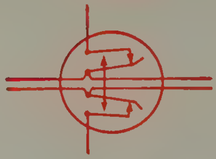

SEPARABLE CONNECTORS
SHORTING SWITCH
MECHANICAL MAKE-BEFORE-BREAK SPRING CONTACTS
TO EQUIPMENT TERMINAL BOARD

for Multiple Circuit Controlling and Switching

KEY NORMAL



KEY OPERATED



You'll get simple, safe, positive operation in multiple circuit controlling and switching with Power Equipment Push Keys. Developed for a wide range of communications applications, they're designed around a foolproof mechanical interlock which effectively prevents dual operation. By a patented system of cams, it is impossible for two keys of any one strip to be in depressed position at the same time. One key is automatically disengaged before a second key can be locked into place or make its contacts. Simple, compact, self-restoring. Provides faster, more convenient switching. Eliminates patching cords and cord maintenance. Equipped with separable connectors for easy plug-in type assembly, and colored plastic buttons for quick circuit and equipment identification. Write today for complete information and application data.

POWER EQUIPMENT Company

55 ANTOINETTE STREET / DETROIT 2, MICHIGAN

Specialists in Controlled Rectifiers Since 1935

(*Continued from page 28A*)

and is designed especially for residential suburban and traffic circle lighting. For further information write for bulletin GEA-5141, General Electric Company, Schenectady 5, N. Y.

Vibration Measurement Equipment. Massa Laboratories, Inc., of 3868 Carnegie Avenue, Cleveland 15, Ohio, have produced a new Massa model *GA-1006* vibration measurement equipment, which employs an accelerometer which is designed to give a uniform electrical output for constant acceleration over the entire frequency range ten cycles to 20 kc. Its output is linearly proportional to mechanical vibrations corresponding to accelerations ranging from less than 0.001 g. to more than 100 g. The accelerometer responds only to vibrations applied along its principal axis and therefore can be used to measure the absolute vector components of any vibration existing at any point on the structure under test. Because the phase shift between the mechanical vibration and the generated electric voltage is independent of frequency over the entire frequency range to 20 kc, very accurate transient vibrations may be reproduced electrically without changes in wave shape of the vibrations. A self-contained power supply unit makes the equipment conveniently portable for field applications. Further information is obtainable upon request.

Circuit Interrupters Available in Cast Iron Enclosures. The Square D Company has announced manufacture of circuit interrupters in cast iron enclosures, which provide a more extensive range of application. The enclosures include weatherproof, dust-tight, dust-resisting, and explosion-resisting types, but do not have thermal and magnetic trip features. For further information, write the Square D Company, 6060 Rivard Street, Detroit 11, Mich.

Magnetic Motor Starter and Motor Contactor. A new magnetic motor starter and magnetic contactor designed to give maximum protection to a-c motors up to 50 horsepower 440 volts, has been placed on the market by the Trumbull Electric Manufacturing Company, of Plainville, Conn. Two features of the new product are bimetallic relay heaters, which accurately will follow the heating curve of the motor, and a plastic encased coil, designed to protect the windings from moisture, corrosion, and abrasion. The coil has a permanent, self-lubricating composition impregnated into the plastic that will keep the magnet guides sliding smoothly. An illustrated bulletin TEC-11 may be had by writing to the company.

Midget Meter. International Instruments, Inc., of New Haven, Conn. announces development of a midget (1-inch) meter with a scale arc of 270 degrees, which will provide a scale chord even longer than that obtainable on conventional meters. The instrument has been developed for special uses in aircraft applications, operates on the same general principles as do the conventional D'Arsonval moving coil types. For further information concerning the midget meter, write to L. E. Thomas, International Instruments, Inc., 331 East Street, New Haven, Conn.

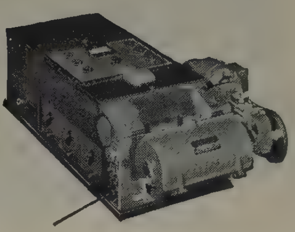
Motor Generator. Kato Engineering Company, of Mankato, Minn., has announced manufacture of a motor and generator assembly which permits obtaining five or six different frequencies of alternating current simultaneously. The motor runs at synchronous speed, and a silent chain is used to transmit power to each of the generator shafts. Further information upon request.

(*Continued on page 38A*)

GENERAL ELECTRIC PRECISION INSTRUMENTS—

For Broader Horizons in Laboratory Testing!!

Type PM-10 Multielement Oscillograph



For Increasing the Scope of Your Investigations, Design, and Testing—

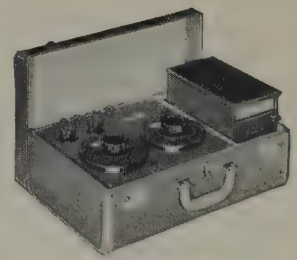
The PM-10 oscillograph has provided the answer to many baffling electric and nonelectric problems. You can use it separately for laboratory-type measurement of electric quantities. And, with auxiliary detectors, you can measure such nonelectric quantities as stress, strain, sound, pressure, and vibrations.

Important PM-10 Conveniences—

1. Simultaneous viewing and recording of as many as twelve separate functions.
2. Frequency response up to 7000 cycles per second.
3. Timing lines photographed on the film.
4. Self-contained control rheostats.

More details are available.*

PORTABLE PRECISION POTENTIOMETER
for measuring very low voltages



Extremely accurate temperature measurements—even to a fraction of a degree—are now possible with the General Electric Portable Precision Potentiometer. Intended primarily for use with thermocouples, this instrument was especially designed for use outside the laboratory, yet it maintains laboratory accuracy. It can be used to get precise data required for determining the efficiency of turbines, oil burners, and other equipment.

BECAUSE OF ITS EXTREME ACCURACY it can be used to check other high-accuracy thermocouple-type indicating and recording instruments, or for measuring any small, d-c potentials.

A convenient system of keys is provided to enable readings to be taken rapidly. All contacts are enclosed to prevent wear due to dust and dirt conditions.

The entire instrument is housed in an attractive luggage case of modern design. The galvanometer element may be removed and used separately.

***FOR MORE INFORMATION** on these two precision instruments, or any of the hundreds of other laboratory, switchboard, or general testing instruments made by General Electric, see your nearest G-E representative. He will be glad to discuss your particular application. If you don't know where he's located, write to us. We will pass your inquiry on to him. Sect. 602–147 *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC
602-147

Here's on-the-job proof of instrument performance!

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The *Coordinated Design and Styling* of Westinghouse instruments contribute greatly to the space-saving arrangement and excellent appearance of this installation.

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What are YOUR electrical measuring problems?

Would they include—reliable performance . . . styling . . . size . . . readability . . . or different types of service . . . portable . . . switchboard . . . panel . . . recording?

The vast lines of Westinghouse electrical measuring instruments provide you with the answers to all of these problems. Every Westinghouse instrument is backed up by more than 60 years of skill, "know-how", and experience in every field of industry.

Westinghouse Instruments Also Provide You With

- Dials that *stay* white under all conditions.
- Magnets that stay permanent.
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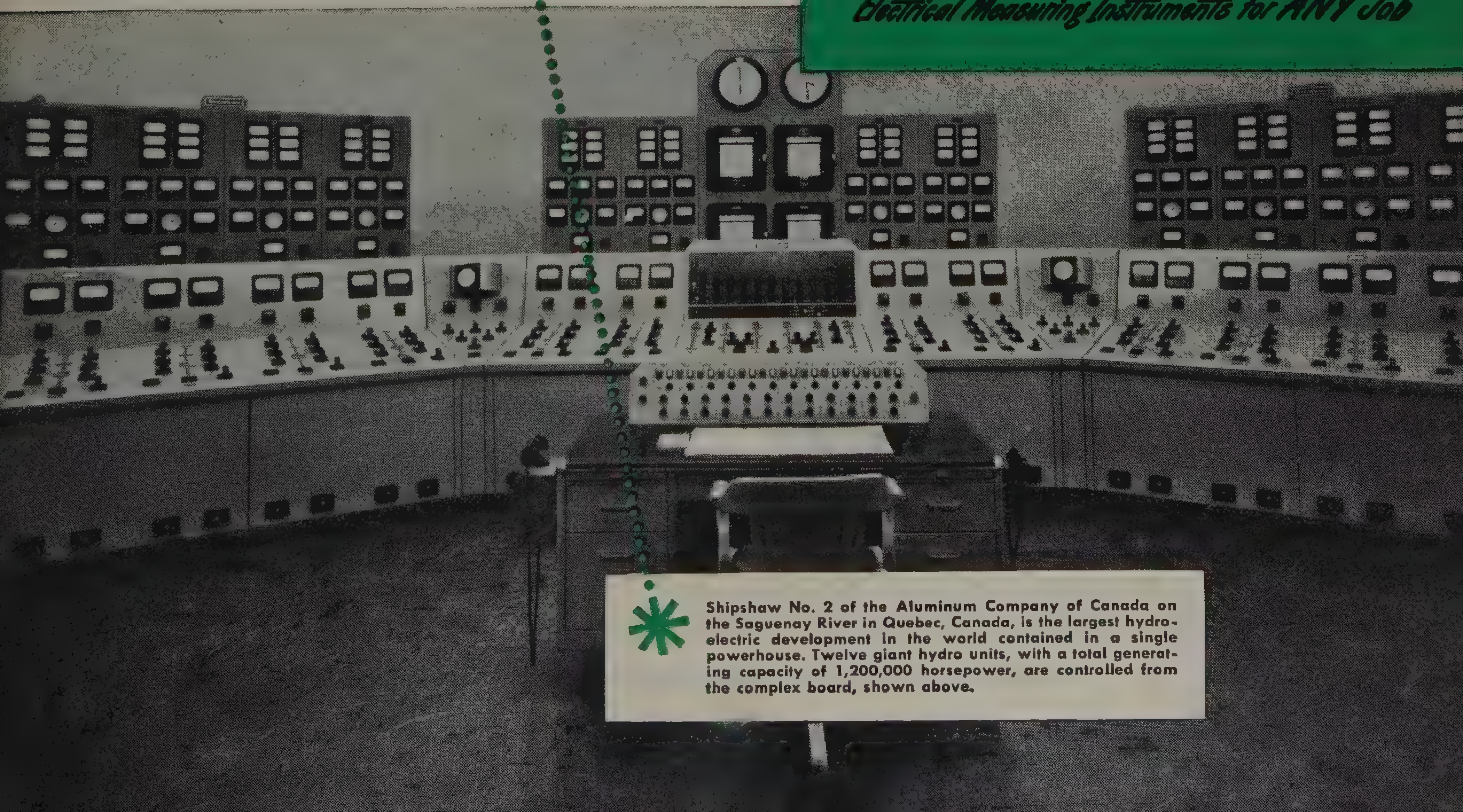
Westinghouse instrument specialists are available in the field for consultation on your instrument problems. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

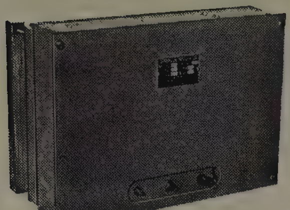
Send for booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-3363.

YOU CAN BE SURE... IF IT'S Westinghouse

Electrical Measuring Instruments for ANY Job



Shipshaw No. 2 of the Aluminum Company of Canada on the Saguenay River in Quebec, Canada, is the largest hydroelectric development in the world contained in a single powerhouse. Twelve giant hydro units, with a total generating capacity of 1,200,000 horsepower, are controlled from the complex board, shown above.



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Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under SIMULTANEOUS line and load changes.
SIX IMPORTANT SORENSEN FEATURES:

1. **Precise regulation accuracy;**
2. **Excellent wave form;**
3. **Output regulation over wide input voltage range;**
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5. **Adjustable output voltage, that once set, remains constant;**
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The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

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Electric means containing, producing, arising from, actuated by, or carrying electricity, or designed to carry electricity and capable of so doing.

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Price : $1.00
($1.25 outside postal USA)

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(*Continued from page 32A*)

RCA Carfone. A new 2-way mobile radio transmitter-receiver, designed to operate in the 152–174-megacycle band, recently was announced by the Radio Corporation of America. The new Carfone makes it possible to operate in channels between stations now on the air without "spillover" into adjacent channels, thus opening new facilities to police, fire departments, and taxicab and trucking fleets. Controls and loud-speaker are combined in a single compact unit for attachment under the dashboard; the receiver itself is contained in a single metal-shielded unit slightly larger than a shoebox. A newly developed circuit for automatic modulation control locks the voice input level at a constant amplitude. Further information is available by writing directly to the Radio Corporation of America, RCA Victor Division, Camden, N. J.

Stainless Degreasers. A new line of completely automatic, push-button controlled vapor degreasers, on which all surfaces exposed to solvent vapors are protected by stainless steel, now are being manufactured by the Circo Products Company of Cleveland, Ohio. The Circo degreasers also feature a 20 per cent increase in work capacity and a built-in resevoir tank for liquid solvent flushing and for automatically restoring solvent to proper operating level in the tank. Additional information upon request.

Magnetic Amplifiers. The Vickers magnetic amplifier is a device for increasing, by means of a magnetic core, the power associated with a signal, through control by the amplifier input of a larger amount of a-c power supplied by a local source to the amplifier output. The fundamental control schemes employed in these applications involve general use of tubeless amplifier circuits. They are widely applicable in industrial or commercial fields. D-c control is advantageous, but a-c phase or amplitude control is feasible if reduced gain is permitted. If ultimate performance is required with a-c signal, a demodulation circuit should be added and d-c control employed. It is a completely static device, and power supply requires no rectifiers or filters, consisting merely of the single-phase or polyphase a-c line voltage. Additional information may be had by writing to Vickers Electric Division, Vickers, Inc., 1815 Locust Street, St. Louis 3, Mo.

Resistant Rubber Compounds. The Stalwart Rubber Company has produced a new line of synthetic rubber compounds developed specifically to resist chemical action of petroleum products, and other industrial and commercial lubricants. Buna N, Hycar, or Neoprene-based, the compounds can be fabricated into gaskets, sleeves, washers, tubing, molded products, and extruded cross sections. Rubbers having tensile strength from 500 to 2,500 pounds per square inch, durometer hardness from 40 to 90, and elongations from 100 to 600 per cent can be supplied according to specifications. These rubbers are

(*Continued on page 48A*)

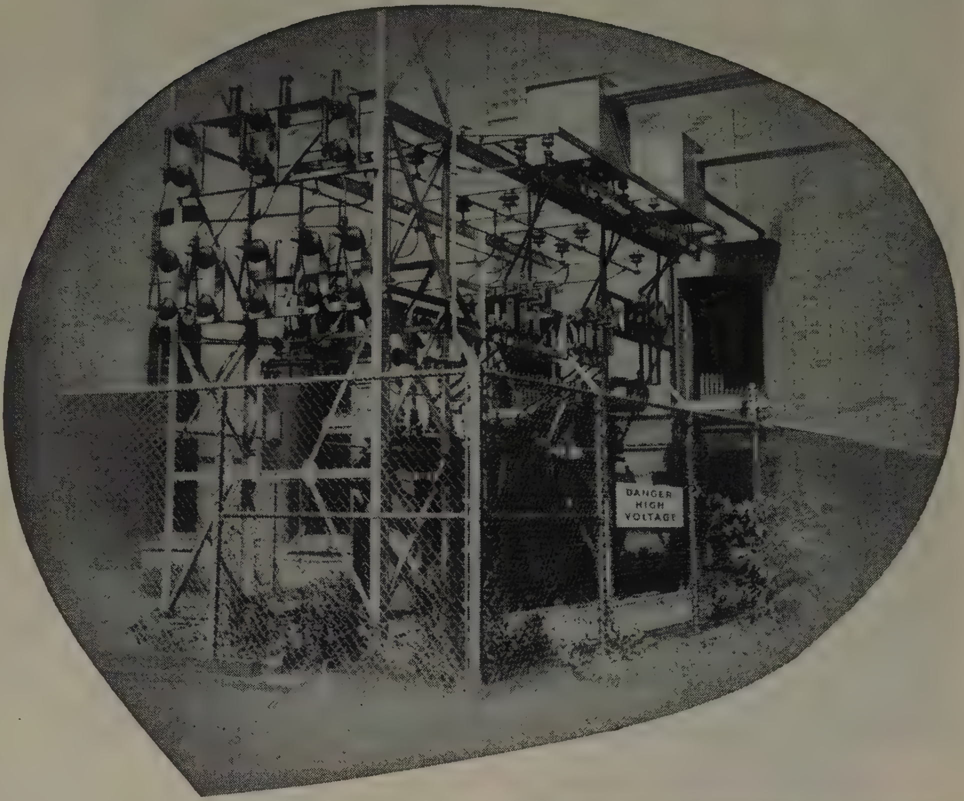
Latest Development in

SORGEL Unit Sub-Stations

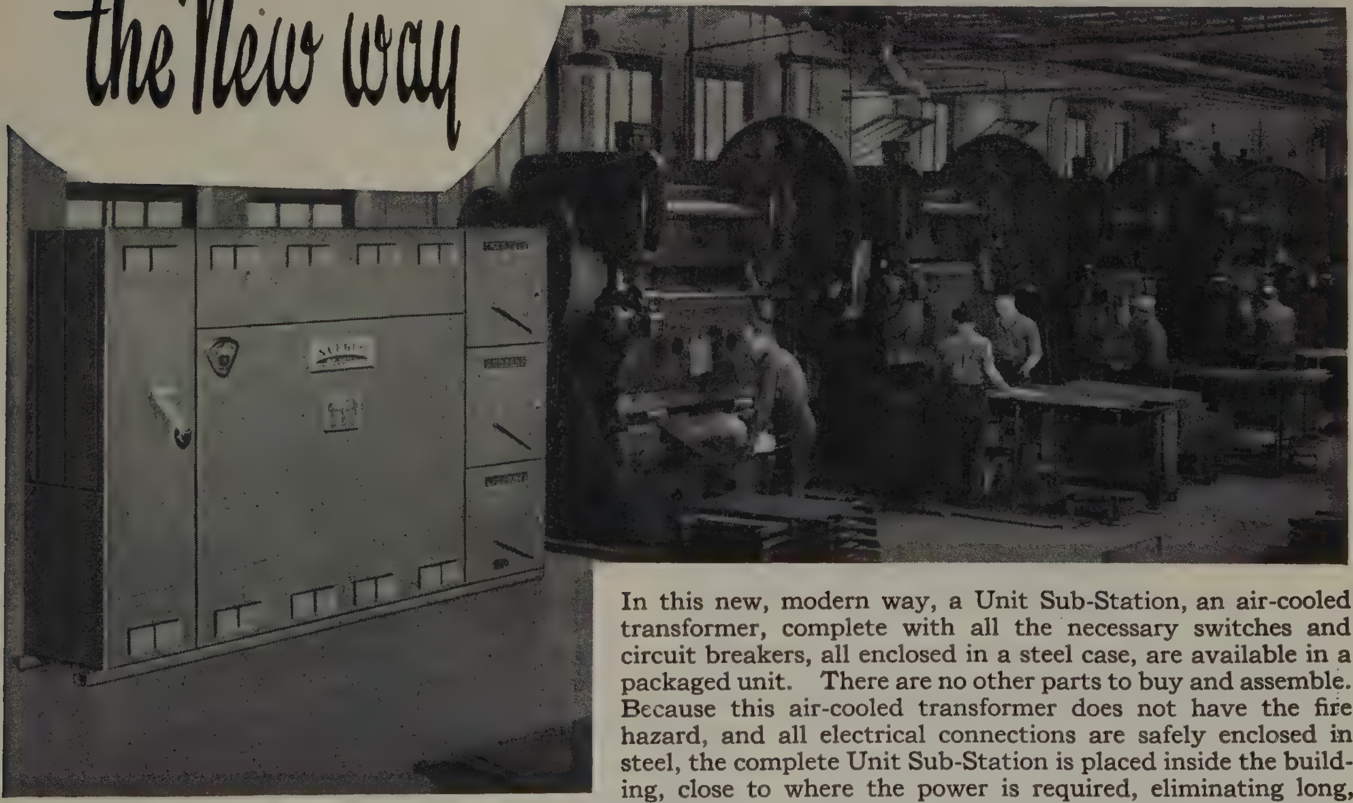
the Old way

In the old conventional way, a transformer immersed in oil was used with the various switches, fuses and fittings, assembled and connected together on a framework.

On account of the fire hazard of the oil, and the large amount of space required, this type of Sub-Station was usually placed outside the building. Exposed high voltage made it necessary to enclose the complete installation within a high protecting fence. Maximum efficiency could not be obtained, due to losses from long runs of secondary feeders.



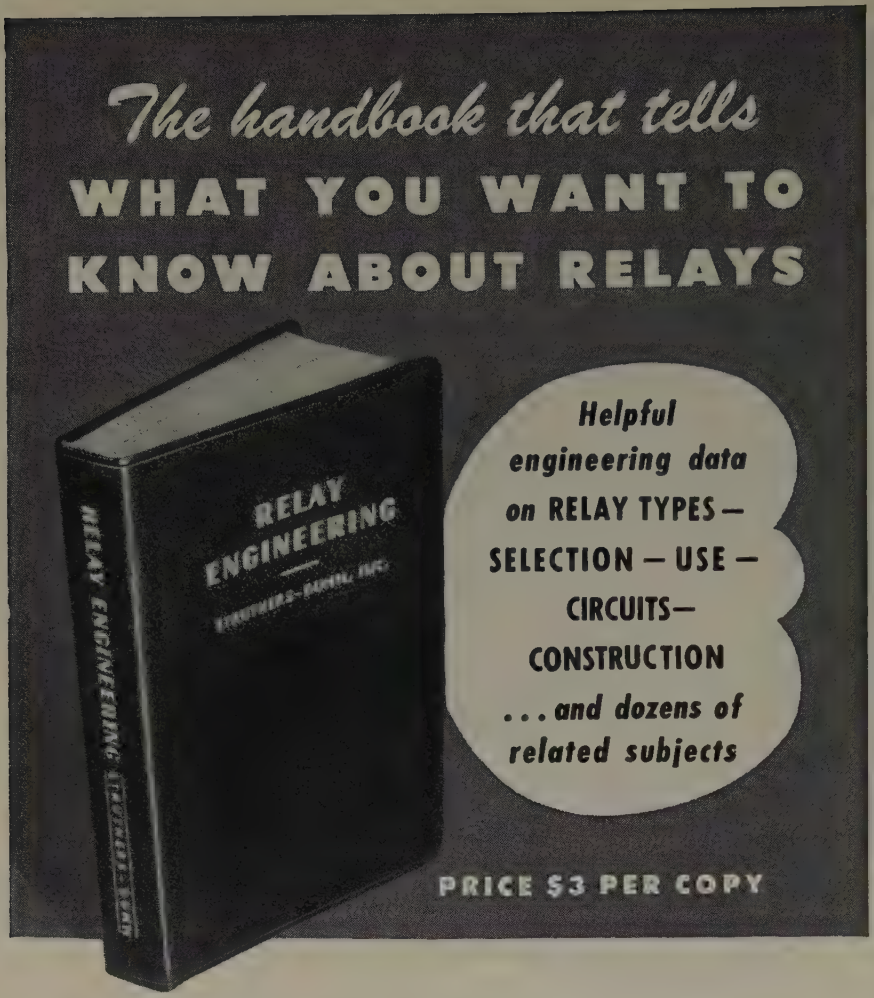
the New way



In this new, modern way, a Unit Sub-Station, an air-cooled transformer, complete with all the necessary switches and circuit breakers, all enclosed in a steel case, are available in a packaged unit. There are no other parts to buy and assemble. Because this air-cooled transformer does not have the fire hazard, and all electrical connections are safely enclosed in steel, the complete Unit Sub-Station is placed inside the building, close to where the power is required, eliminating long, costly secondary feeders. These modern **Sorgel** Unit Sub-Stations are compact and require considerable less space than the old type Sub-Stations. Available in sizes 100 to 2000 Kv-a. All voltages up to 15,000 volts.

SORGEL ELECTRIC CO.

846 West National Ave., Milwaukee 4, Wis.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WHAT YOU WANT TO KNOW ABOUT RELAYS
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Helpful engineering data on RELAY TYPES—SELECTION—USE—CIRCUITS—CONSTRUCTION ...and dozens of related subjects
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This 640-page RELAY ENGINEERING HANDBOOK brings you full benefit of Struthers-Dunn's experience in producing millions of relays in thousands of types for hundreds of uses. Replete with more than 1100 illustrations, it is the ideal book for everyone concerned with modern relay or timer application, use or maintenance.

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Mercury contact
Direct current
High-Voltage
Lamp Control
Sequence (ratchet and multi-pole)
Close differential
Overload
Telephone auxiliary signaling combinations
DB timers for continuous processes

(*Continued from page 38A*)

also capable of withstanding temperatures ranging from 60 to 225 degrees Fahrenheit. Further information is available from The Stalwart Rubber Company, 194 Northfield Road, Bedford, Ohio.

"Packaged" Generators. The complete unit of generator, exciter and built-in voltage regulating circuit recently announced by Electric Machinery Manufacturing Company has been extended to include a self-contained main generator switch on ratings up to 15 kv. No additional switches or controls are necessary, as the unit is connected directly to the load. The complete "packaged" generator line features units in single and 3-phase ratings up to 150 kw at speeds of 900 to 1800 rpm. For further information, write for publication 2100-115, Electric Machinery Manufacturing Company, Minneapolis 13, Minn.

High-voltage Resistor. A new resistor manufactured for high-voltage applications is now being produced by the International Resistance Company, Philadelphia, Pa. Designated as type *BTAV* this new resistor is a variation of the company's "Advanced *BT*," with features that enable it to operate continuously at much higher voltages than the maximum rated voltage of the standard BT resistor, and to withstand surges up to 6,000 volts.

TRADE LITERATURE

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Electrical Resistance Heating Elements. A technical pamphlet, which describes an improved system of electric resistance heating, the principles involved, and specific applications, has been released by the Safeway Heat Elements, Inc., of 76 Water Street, Middletown, Conn. Copies sent upon request to the company.

Catalog of Technical Books. Free copies of the new 1949 catalog of technical books "Let's Look It Up," published by the Reinhold Publishing Corporation, now is available. Address requests to 330 West 42nd Street, New York 18, N.Y.

Welwyn Resistor Data. An 8-page catalog covering technical data and complete price schedules on Welwyn high stability carbon resistors, and Welwyn Pyromatic resistors may be obtained by writing to Welwyn Electronic Components, Inc., 234 East 46th Street, New York 17, N.Y.

Micromax Recorders and Controllers. A 32-page catalog listing a complete line of the Leeds and Northrup Company strip-chart Micromax recorders and controllers for measuring a wide variety of process variables is now available. The booklet, "Micromax Model S—Indicating Recorders and Con-

(*Continued on page 56A*)

IT WON'T BREAK if it's a new O.Z. ALL-BAKELITE BUSHING!

BOUNCE IT

Bounce an O. Z. All-Bakelite Insulating Bushing hard, on a concrete floor — it rebounds good as new. Add to its superior strength* these extra features and you've got a bushing that's best by any test!

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*56% stronger over all than all other leading all-Bakelite bushings actually tested by an independent laboratory.

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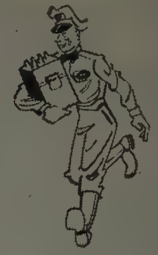
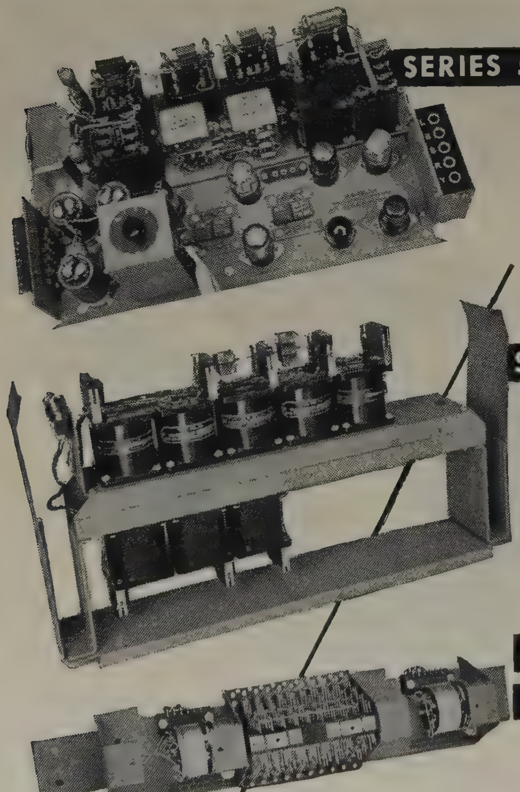
4899

ADC Quality Wins Again

ADC

An important part of WESTERN UNION'S nationwide plant mechanization program is the new Type 20 FM Carrier Channel Terminal equipment. Designed to provide telegraph message channels for the interconnection of telegraph offices, this new equipment was ordered in large quantities from the Radio Corporation of America in the fall of 1946. **ADC** was chosen to provide the transformers and inductors—over 85,000 coil assemblies were produced by **ADC** under rigid specifications and on individual test inspection only 14 were rejected.





SERIES 550-50 TRANSCEIVER

When Western Union recently ordered additional quantities of this equipment, Radio Corporation of America again won the contract award and **ADC** was again chosen for the transformers—inductors.

SERIES 550-50 TUNER

The accompanying photographs show three of the principal components of Western Union's Type 20 FM Carrier Channel Terminal equipment.

SERIES 2-A
CARRIER COUPLER

Series 550-50—Tuner
Series 550-50 } Transceiver
Series 2-A } Carrier Coupler

This proven dependability of **ADC** QUALITY PRODUCTION is available to *you* . . . submit your specifications or problems for prompt attention.

ADC *Audio* DEVELOPMENT CO
Audio Develops the Finest
2853 13th AVE. SOUTH · MINNEAPOLIS 7, MINN.

(*Continued from page 48A*)

trollers," may be obtained by writing for catalog ND44 (1), Leeds and Northrup Co., 4934 Stenton Avenue, Philadelphia 44, Pa.

Thermocouple Manual. A 40-page bulletin (T/C 7), just released by the Wheelco Instruments Company, provides information on selection of proper thermocouples and protecting tubes, methods of checking thermocouples and pyrometers, and installation data. Illustrations and price lists are included. Write to Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Ill.

Bare and Weatherproof Wire and Cable. Photographs and tabular data on bare and tinned, and weatherproof wires and cables recently has been published in a 44-page catalog by the Rome Cable Corporation. American Standards specifications for weatherproof wire type *URC* is also included. Address requests for catalog number 22 from the Rome Cable Corporation, Rome, N. Y.

Lubri-tact Tubular Rheostats. Bulletin 41-7, published by James Biddle Company describes the various styles of rheostats, including "Jagabi" Lubri-tact. Address request to James Biddle Company, 1316 Arch Street, Philadelphia 7, Pa.

Precision Variable Resistors. The type RV2 high precision potentiometer manufactured by the Technology Instrument Corporation, has been completely described in a recent booklet which contains illustrations, dimensional and explanatory diagrams, and a price list. Copies are available upon request from the company, at 1058 Main Street, Waltham 54, Mass.

Electrical Brushes Catalog. A catalog on carbon brushes for electrical machines is now being distributed upon request by the United States Graphite Company, division of the Wickes Corporation, Saginaw, Mich. The catalog is illustrated in color, and gives brief descriptions, sizes, types, and materials used of the products listed.

Die-Casting Catalog. "Zinc Die Castings" is the title of a new catalog recently issued by the New Jersey Zinc Company, of 160 Front Street, New York 7, N. Y. The 63-page catalog depicts the use of zinc die castings in the assembly of 167 different products in ten major consuming fields. Copies are available upon request.

Radio Manufacturers Association Standards Releases. The RMA lists the following 13 new recommended standards: Audio Facilities for Radio Broadcasting Systems (TR-105-A); Numerical Values, Decimal Multipliers, and Tolerances (GEN-101); Preferred Values (GEN-102); Moulded

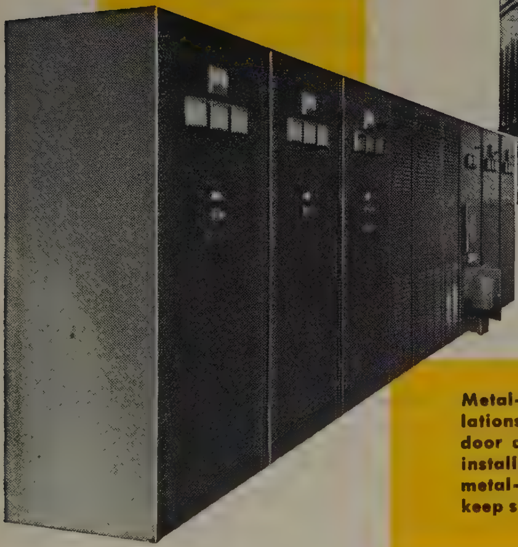
(*Continued on page 58A*)

cast-in-concrete

Current-limiting Reactors

INDUSTRY'S FAVORITE FOR 35 YEARS

This 25-year-old installation has required practically no maintenance, has given no trouble. It consists of thirty-six 120-kva 3-phase 22,000-volt cast-in-concrete reactors, each giving a 3-per-cent reactive drop.



Metal-enclosed reactors can be matched to switchgear installations, and are becoming increasingly popular for both indoor and outdoor service. Here, three 3-phase reactors are installed between switchgear equipments. As with all G-E metal-enclosed reactors, the enclosure is specially designed to keep stray current — and electrical losses — to the minimum.

Nothing tops these cast-in-concrete reactors in mechanical or electrical strength, in resistance to weathering, or in long maintenance-free life. Conductors and concrete are a one-piece structure—with rock-like resistance to weathering and with the strength and rigidity to withstand short-circuit magnetic forces. Good clearances, elimination of through bolts, and crossovers made within the concrete supports give maximum protection against flashover. Special treatment during finishing processes renders them highly resistant to moisture.

Almost from the day they were introduced, 35 years ago, General Electric cast-in-concrete reactors have outsold all other current-limiting reactors by a substantial margin. And today—wherever you want a reactor to limit short-circuit current, to protect service on other parts of your system or reduce the current-interrupting duty of your breakers—they are still unbeatable.

Usual ratings range from 50 to 1500 amperes, and voltages up to 34,500. Details are given in publication GEA-976. *Apparatus Department, General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

401-56

(*Continued from page 56A*)

Mica Capacitators (REC-115); Fixed Composition Resistors (REC-116); Fixed Wire Wound Resistors (REC-117); Electrical Performance Standards for Television Relay Facilities (TR-106); Fixed Paper Dielectric Capacitors in Tubular Non-Metallic Cases (REC-118); Vibrator Power Transformers (REC-119); Power Transformers for Radio Broadcast Receivers (REC-120); Variable Control Resistors (REC-121); High Frequency Circuit Switches (REC-122); Designation System for Cathode Ray Tubes (ET-111). Further details can be obtained from the Radio Manufacturers Association, 1317 F Street, N. W., Washington 4, D. C.

1949 Directory of Occupational Safety Posters. Published by the National Safety Council, contains 72 pages of black-and-white and color posters suitable for use in business and industry and covering all phases of occupational safety. 744 illustrations divided into 15 sections. Priced at 50 cents, the directory is available from the National Safety Council, 20 North Wacker Drive, Chicago, Ill.

Uses Unlimited. A film on the snap-action switch, its development and uses. Available without cost from Micro Switch, Film Exchange, Freeport, Ill.

Steam for Power. A 16-millimeter film depicting the development and applications of modern steam boilers, in color. Available free of charge to engineering and professional societies, schools, and all groups interested in power generation and utilization from Advertising Division, The Babcock and Wilcox Company, 85 Liberty Street, New York 6, N. Y.

Allis-Chalmers Bulletins. "Allis-Chalmers Engine Type Synchronous Generators," bulletin *05B6139A*, contains construction features and electrical characteristics of Allis-Chalmers engine-type synchronous generators available in all standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm for Diesel, steam, or gas engines. "Allis-Chalmers Switchgear and Control Devices," bulletin *25B7095*, describes the company's broad line of switches, regulators, circuit breakers, transformers, relays, contactors, and other control devices. The third bulletin, *05B7150*, "Allis-Chalmers Totally-Enclosed Fan-Cooled Motors," describes the features of Allis-Chalmers totally-enclosed fan-cooled motors with tube-type air-to-air heat exchangers. Ratings of the motors range from 150 horsepower at 1,200 rpm to several thousand horsepower, at standard speeds of from 3,600 rpm to about 300 rpm. All three bulletins are available upon request to the Allis-Chalmers Manufacturing Company, South 70th Street, Milwaukee, Wis.

Cornell-Dubilier Encyclopedia. A new 56-page booklet number 163, which is a complete encyclopedia for capacitors used in capacitor-type motors, has been published by the Cornell-Dubilier Electric Corporation, of South Plainfield, N. J. It includes such items as interchangeability tables with instant selector indexes, replacement tables, technical information, and interference filters. Address requests for the booklet to the jobber division of Cornell-Dubilier.

Wales-Strippit Catalogue. The Wales-Strippit Corporation of 345 Payne Avenue, North Tonowanda, N. Y., has issued a new "BL" catalog which describes Wales-type "BL" hole punching units for punching mild steel up to one-eighth-inch thick. The 32-page catalog features the new punch retainer designed to hold the punch in the self-contained holder and at the same time facilitate removal of the punch by contracting the retainer spring. It is functionally illustrated in color, and contains additional information of various types of setups, and "BL" unit series. Available upon written request to the Wales-Strippit Corporation.

Speedomax Instruments. Leeds and Northrup's complete line of Speedomax instruments–indicators, indicating recorders, and recording controllers, have been described and illustrated for the first time in a new 44-page catalogue, ND46 (1). Called "Speedomax Type G Instruments," it explains these high-speed high-sensitivity instruments and all the uses for which they are now available. For a copy of the publication, write to Leeds and Northrup

(*Continued on page 60A*)

Elements of Nucleonics for Engineers

This publication contains a series of articles on nucleonics published in ELECTRICAL ENGINEERING and sponsored by the AIEE committee on nucleonics which was formed in 1946 in recognition of the very direct interest of the electrical engineer in the field of nuclear physics. Now combined in a single volume, the articles provide a convenient primer of nuclear theory.

CONTENTS

The Atom and Its Nucleus
  by J. J. Smith
The Relation Between Energy and Mass
  by Frederick Seitz, Jr.
The Nucleus—Its Structure and Reactions
  by W. E. Shoupp and Hugh Odishaw
Nuclear Engineering
  by E. U. Condon
Detection and Measurement of Nuclear Radiation
  by G. Wesley Dunlap
The Separation of Isotopes
  by G. Wesley Dunlap and R. M. Lichtenstein
Cascades Used in Isotope Separation
  by Harold C. Urey
Nuclear Reactors—Some Basic Considerations
  by F. L. Friedman
High-Energy Particle Accelerators
  by J. R. Woodyard
Physical and Medical Aspects of Radiation
  by L. L. German and H. M. Rozendaal
Nuclear Reactors for Power Generation
  by Ward F. Davidson
Suggested Bibliography
  Sources of further information

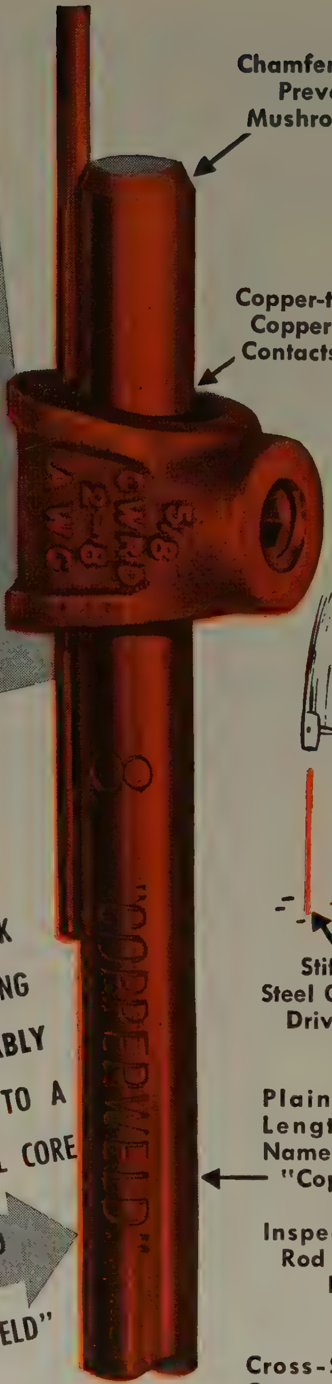
Copies of "Elements of Nucleonics for Engineers" are available at 80 cents each (40 cents to AIEE members) and may be obtained from the AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS New York, N. Y.

Be Sure They're "COPPERWELD"

for **25 YEARS**, this name on **Ground Rods** has meant

PERMANENT GROUNDING PROTECTION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When you use Copperweld non-rusting Ground Rods and Clamps, the possibilities of corrosion and high resistance connections are eliminated. Millions of Copperweld Ground Rods and Clamps, now in service, have proved their superiority by rendering permanent grounding protection.

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THE ONLY GROUND ROD WITH A THICK COPPER COVERING INSEPARABLY MOLTEN-WELDED TO A STIFF ALLOY STEEL CORE IS STAMPED "COPPERWELD"

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AIEE Special Publications

The following is a list of special AIEE publications that are or will be available currently:

	Price	
	Members	Non-Members
☐ Application of Electric Conversion Equipment to the Electrochemical Industry (November 1947)	.40	.80
☐ Bibliography on Electrical Safety 1930–1941 (July 1942)	.25	.50
☐ Bibliography on High-Frequency Dielectric Heating (August 1947)	.35	.75
☐ Bibliography on Power Supply for Electric Welding—1930–47 (June 1948)	.30	.60
☐ Electric Power Applications in the Textile Industry (September 1947)	.40	.80
☐ Electric Power Distribution for Industrial Plants	1.00	1.00
☐ Electric Power in the Pulp and Paper Industry (February 1948)	.50	1.00
☐ Electrical Engineering Problems in the Rubber and Plastics Industries (October 1948)	1.50	3.00
☐ A. Electron Tube Survey of Instrument Manufacturers and Laboratories (March 1948)	1.00	2.00
☐ B. Electron Tubes for Instrumentation and Industrial Use (November 1948)	1.50	3.00
☐ Combination of Electron Tube Reports—Items A and B listed directly above	2.00	4.00
☐ Grounding Principles and Practice (June 1945)	.50	.50
☐ Nucleonics Series (available April 1949)	.40	.80
☐ Power Supply for Resistance Welding Machines—Parts 1 and 2 (May 1940)	.25	.25
☐ Part 3 (April 1941)	.25	.25
☐ Progress in the Art of Metering Electric Energy (December 1941)	.25	.50
☐ Statistical Methods in Quality Control (February 1948)	.35	.70
☐ Telemetering, Supervisory Control and Associated Circuits (September 1948)	1.00	2.00
☐ Tidd 500-Kv Test Lines (January 1948)	.50	1.00
☐ Ultrashort Electromagnetic Waves (December 1943)	.50	.50

Also available is the following publication issued by the Engineer's Joint Council of which AIEE is a member:

☐ The Engineering Profession in Transition (1947)	.50	1.00

Stocks of these special publications are limited but orders will be filled as fully as possible in order of receipt.

AIEE Order Department,
33 West 39th Street, New York 18, N. Y.

Remittance enclosed $...

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Street ....

City..............................Zone......State.......

(Continued from page 58A)

Company, 4934 Stenton Avenue, Philadelphia 44, Pa.

Battery Technology Handbook. The Gould Storage Battery Corporation of Trenton 7, N. J., recently published a new 40-page pocket-size handbook of instructions and engineering data on the care of motive power batteries. The illustrated handbook is divided into four sections: Care and Operation, Maintenance and Repairs, Parts, and Technical Data. Copies can be obtained without charge from the company. Write for "Gould Instructions and Technical Data for Rubber Jar Batteries."

Gibson Contact Rivets. Electrical contact rivets manufactured by Gibson Electric Company, 8350 Frankstown Avenue, Pittsburgh 21, Pa., have been described in a new catalog, *C-12.* A description of the materials and standard sizes of the flat, crowned, and pointed contact rivets is given also. Address requests for the catalog to the company.

W. N. Matthews Bulletin. Bulletin *103-S,* published by the W. N. Matthews Corporation, of 3850 Delor Street, St. Louis, 16, Mo., illustrates and describes wood-housed Matthews fuswitches in ratings of 50, 100, and 200 amperes, 5,000 and 7,500 volts. Also included are reprints of oscillographs which show these fuswitches clearing short circuits in excess of 8,000 amperes at 4,150 volts. Information on porcelain-housed Matthews fuswitches and cutouts is given also. Copies available upon request to the company.

Voltage Bulletin. Sorenson and Company, manufacturers of electronic voltage regulation equipment, publish a bimonthly house organ devoted to new developments in the voltage regulation field. The bulletin is entitled "Currently," and is available upon request to Ed McCarthy, editor, "Currently," Sorenson and Company, Inc., 375 Fairfield Avenue, Stamford, Conn.

Booklet on Selenium Rectifiers. The Fansteel Metallurgical Corporation, North Chicago, Ill., has published a new booklet, Bulletin *RDP-112,* which contains complete engineering data on selenium rectifiers, and has been designed to aid users of rectifiers to select, buy, and use them properly. Copies supplied upon request to the Fansteel Metallurgical Corporation.

Westinghouse Quicklag Loadcenter. Information about the Westinghouse Quicklag Loadcenter is given in a new 12-page booklet, which contains discussion on flexibility, required inventory, performance, and installation of the product. The Quicklag circuit breakers are the thermal-magnetic type that provide time delay on overloads and instantaneous tripping on dangerous overloads and short circuits. Copies of booklet *B-3881* may be obtained by writing directly to the Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

HIGHLIGHTS........

Committee Notes. A new department, "Committee Notes," has been created for the convenience of the various technical committees. Inaugurated with the April issue, this department is expected to appear monthly in the "Institute Activities" section of *ELECTRICAL ENGINEERING.* It will include brief items reporting committee activities and plans for special conferences, meeting sessions, and so forth. Items for the department should be as short as possible and should be submitted to R. S. Gardner at AIEE headquarters (*pages 455–7*).

Meetings. The next general meeting of the Institute will be the always popular summer general meeting, to be held this year in Swampscott, Mass., June 20–24 (*pages 452–3*). Following that, the Pacific general meeting will be held in San Francisco, August 23–26 (*page 453*). Two forthcoming conferences are the one day conference on electric equipment for materials handling bridges on May 13 in Cleveland (*page 452*), and a second conference on the textile industry, May 26–27 (*page 452*).

Vaporization Cooling. A standard universal solution for the cooling of large machines of all types has been made feasible. The principles of vaporization cooling are so different from those customarily associated with other media as air, hydrogen, and fluid, that for a proper evaluation one must make oneself free from any preconceptions (*pages 385–92*).

Rubber Insulators. Because glass insulators on pole lines in some areas are subjected to much mischievous breakage, rubber insulators have been developed which solve the damage problem. In addition, over a period of nine years these rubber insulators have maintained an outstanding record of durability and electrical and mechanical efficiency (*pages 435–8*).

Television Relay. Although a New York-to-Schenectady television relay has been in use since 1940, the original system, which necessitated the passing of the signal through two complete television broadcast transmitters, was subject to several disadvantages. Since 1947, however, a 4-link microwave relay has been employed in the 2,000-megacycle region which has shown definite superiority (*pages 419–22*).

Graduate Education. " . . . with the full co-operation of industry and neighboring educational institutions, many opportunities for graduate technical education may be developed for engineers and scientists who are hungry for the training and have no other opportunities to obtain it." The dean of the graduate school at the Illinois Institute of Technology describes two such programs in which industry is co-operating successfully with the school to bring graduate education to working students who cannot go to the campus (*pages 413–15*).

An Invisible Export. It is generally known that since the war American manufacturers have been exporting large quantities of electric equipment, and, of course, these exports represent a contribution to world recovery. However, the electrical industry of the United States has pioneered in an even more important export, though an invisible one, the export of engineering knowledge through license and technical assistance agreements with foreign manufacturers (*pages 379–82*).

Carrier System. This article describes a carrier program system capable of transmitting a band about 8,000 cycles wide. Its first commercial application was early in 1946, but it is now in use in all sections of the United States (*pages 395–400*).

German Electronics. An investigation of German technical developments of World War II has been made by United States scientists and engineers. A large amount of it has worthwhile features of value to American industry. This article pictures and describes many pieces of equipment (*pages 403–09*).

Fluctuating Loads. In designing boiler units for fluctuating loads, special consideration must be given to many factors. This article discusses the need for such designs, factors which govern pickup time, fuel-burning equipment, draft equipment, and the arrangement of automatic controls (*pages 425–31*).

Electromagnetic Induction. This article discusses the flux linking law and the flux cutting law, which erroneously have been considered as different ways of expressing the same phenomena. An endeavor is made to dispell the confusion surrounding this subject (*pages 441–7*).

Digests. A number of one page digests of technical papers appear in this issue (*pages 383, 384, 393, 394, 401, 402, 410, 411, 412, 416, 417, 418, 423, 424, 432, 433, 434, 439, 440, 448*).

Correction. Because of the confusion arising out of a similarity of names, the April issue incorrectly credited Edward W. Davis instead of Ernest W. Davis with nomination to the AIEE board of directors (*EE, Apr '49, p 364.*) To add to the confusion, the present position and committee affiliations as given were correct for the latter Mr. Davis, as was the cut which accompanied the personal note; although the full name and other biographical details were in error. A corrected biographical sketch on Ernest W. Davis appears in this issue (*page 457*).

AIEE PROCEEDINGS

Order forms for current AIEE *PROCEEDINGS* have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of AIEE *PROCEEDINGS* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *TRANSACTIONS.*

AIEE *PROCEEDINGS* are an interim membership service, issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec' 46, pp 567–8; Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *PROCEEDINGS* will appear in *ELECTRICAL ENGINEERING* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter general (1948)
Aug '48, p 45A	Great Lakes District North Eastern District Summer general
Oct '48, p 43A	Pacific general Middle Eastern District
Dec '48, p 35A	Midwest general Southern District
Apr '49, p 25A	Winter general (1949)

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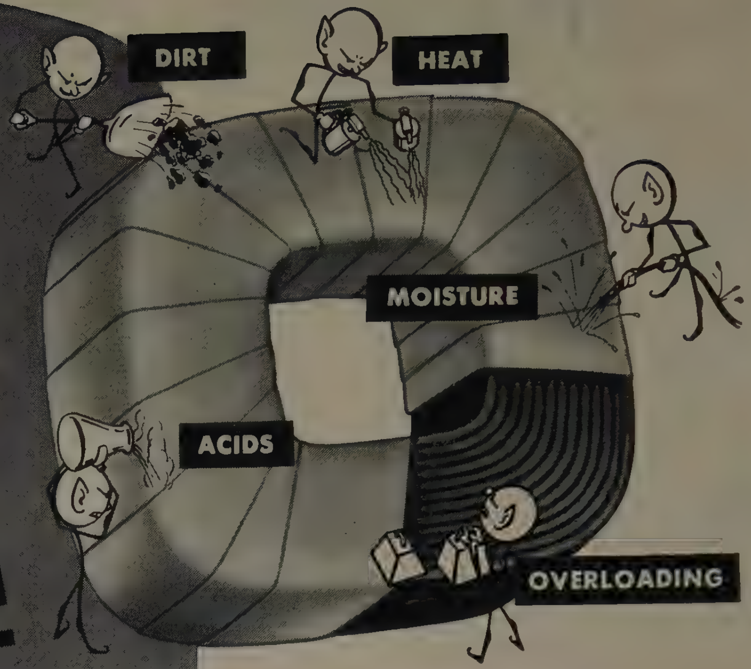
ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. May 1949, Vol. 68, No. 5. Number of copies of this issue 51,500

When
OPERATING
CONDITIONS
are
TOUGH



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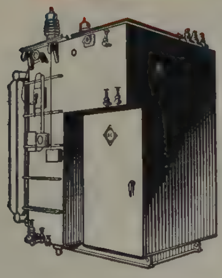
MCS MULTI-CIRCUIT unit substations consist of two or more vertical lift metal-clad switchgear units throat-connected to one or two transformers. **Bulletin 11B6935.**

A2631



ALLIS-CHALMERS SCS SINGLE CIRCUIT unit substations consist of a transformer, secondary breaker and control, *Oil-Sealed* inert gas system for protecting oil, and the 32 5/8% step regulator mechanism for ±10% range of regulation — all combined within a single housing. They can be installed as a unit.

ALLIS-CHALMERS, 931A SO. 70 ST.
MILWAUKEE, WIS.

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ALLIS-CHALMERS

Pioneers in Load Ratio Control — Originators of 5/8% Step Regulation

Silicone News
DC SILICONES

Silicone Insulation Gives 200 Times Class "A" Life in Tread Cutter Motors

Lake Shore Tire and Rubber Specifies Silicone Insulation for Critical Motors

Case histories from all fields of industry prove that Dow Corning Silicone (Class "H") Insulation pays remarkable dividends. The initial cost of rewinding a motor with Silicone Insulation is about twice the cost of a conventional rewind job but Silicone Insulation lasts 10 to 200 times as long. The increase in production that comes of continuous operation is a bonus paid by Dow Corning Silicones.

PHOTO COURTESY LAKE SHORE TIRE AND RUBBER CO.

Rapidly reversing tread cutter motors rewound with Dow Corning Silicone Insulation have more than 200 times the life of Class "A" motors.

At Lake Shore Tire and Rubber Company of Des Moines, Iowa, open type 2 h.p. motors are used to drive disc cutters that scarf cut tread stock into lengths. These motors reverse 12 times per minute and operate in a mist of the water used to lubricate the cutters. Life of Class "A" motors in this service ranged from 4 days to a few weeks. Production suffered and maintenance costs were abnormally high.

Lake Shore's electrical maintenance engineers had these motors rewound with Silicone Insulation over 2 years ago. They have already given as much as 200 times the service life of Class "A" motors. This proof of Silicone economy convinced Lake Shore engineers that DC Silicone insulated motors should be used in other essential production equipment such as McNeil Vulcanizers and Banner Bias Cutters.

Here, as in any production plant, Dow Corning Silicone Electrical Insulation greatly increases the life and reliability of hard working motors and motors on which production schedules depend. For more case histories write for pamphlet G7A4.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
New York • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

INDUSTRIAL NOTES ....

Wynkoop President of Radiomarine: RCA Victor Division News. Rear Admiral Thomas P. Wynkoop, Jr., United States Navy (retired) has been elected president of the Radio-Marine Corporation of America. In the Victor Division of the Radio Corporation of America, the tube department has undertaken construction of a new manufacturing center at Marion, Ind., for the mass production of 16-inch direct-view metal picture tubes for television. The new tube to be produced at the Marion plant is the industry's first metal kinescope, which uses a metal cone or center section instead of an all-glass envelope. New appointments in the tube department include W. L. Rothenberger, assistant general sales manager; William H. Painter, manager of the merchandise division; H. F. Bersche, manager of the renewal sales section; J. Carroll, manager of the equipment sales section; and L. S. Thees, general sales manager. In the materials department of RCA Victor, Vincent dePaul Goubeau was elected vice president in charge.

Westinghouse Appointments; Retirement. William C. Hipple, who has managed the Trenton, N. J., plant of the Westinghouse lamp division for almost 30 years, has retired. In the same division, Carl R. Busch has been appointed district sales engineer for the eastern district, with headquarters in New York City, and Robert L. Zahour has rejoined the Westinghouse lamp division at Bloomfield, N. J. Other appointments announced were those of Robert J. Seybold, assistant purchasing agent of the Westinghouse transformer division at Sharon, Pa; C. W. Mills, sales promotion manager for the northwestern district of the Westinghouse Electric Corporation, with offices in Chicago, Ill.; and L. M. Gumm, metal working consultant for the industrial sales department.

Pinco Appointments. The Porcelain Insulator Corporation of Lima, N. Y., has appointed Davidge H. Rowland as assistant to the president, in addition to his duties as director of research. Mr. Rowland won the AIEE award in 1935 for his paper, "Porcelain for High Voltage Insulators." Another appointment to the Pinco executive staff is that of Lawrence J. Dykstra, now in charge of the company's advertising and sales engineering.

Alan G. Arison Dies. Alan G. Arison, sales engineer for Hubbard and Company in Michigan and Indiana, died recently. Mr. Arison had been with Hubbard for the last 12 years.

Moloney Appointment. The Moloney Electric Company has named John J. Knox as head of sales in the company's new capacitor division. Mr. Knox was appointed a vice president in 1945.

GE News. H. R. Oldfield, Jr., has been appointed manager of sales for the government division of the General Electric Company's electronics department at Electronics Park, Syracuse, N. Y. Mr. Oldfield in turn named J. W. Nelson, Jr., to succeed him as head of the Air Force sales section in the division. Also at Electronics Park, O. K. Lindley has been made assistant sales manager, communications products, for the specialty division. At Schenectady, N. Y., G. W. DeSousa has been named staff assistant to J. M. Leng, divisions manager of the company's tube divisions.

W. N. Matthews Appointment. G. L. Bleich has been appointed by the W. N. Matthews Corporation to the post of sales engineering representative in Nebraska.

Slottman Heads Research at Air Reduction. Doctor G. V. Slottman has been appointed director of research and engineering for the Air Reduction Company, of New York City. Doctor Slottman has been closely associated with Air Reduction's development of steel-making processes using large quantity, low-purity oxygen for both combustion purposes and as a chemical reagent.

G-V Controls Organized. G-V Controls, Inc., 28 Hollywood Plaza, East Orange, N. J., has been organized to engage in the development and manufacture of electrical control equipment. C. D. Geer, who recently resigned as vice president of Thomas A. Edison, Inc., of West Orange, N. J. will act as president of the new company.

Syntron Appointment. George L. Chedsey has been appointed supervisor of mining equipment for the Syntron Company, Homer City, Pa.

RMA 1948 Sales Reports High. The Radio Manufacturers Association announced that the radio-television industry broke all previous annual sales records in 1948, and it is expected that in 1949 well over half of the industry's income will come from television sets.

Minnesota Mining Fills Sales Posts. The Minnesota Mining and Manufacturing Company of St. Paul, Minn. has appointed James J. McDonald, S. P. Van Arsdall, and James J. O'Brien to sales supervisory posts in its electrical insulation and sound recording tape division, with headquarters in New York, Chicago, and Cincinnati, respectively.

Doolittle Radio Appoints Heimark. Harold M. Heimark has been named chief engineer for Doolittle Radio, Inc., Chicago, Ill., builders of precision radio communication equipment.

Dodge Export Manager of Howell. Harry D. Dodge has been made manager of the

(*Continued on page 20A*)

Final Check-up of Economy 42-inch Vertical Axial Flow Pump Courtesy of Economy Pumps, Inc.

A LITTLE STROBOTAC HELPS TO TEST A BIG PUMP

Accurate testing under actual working conditions is a must in the Testing Laboratory of Economy Pump, Inc. of Hamilton, Ohio. Their axial flow pumps are especially designed and custom-built for drainage, irrigation, condenser circulating and other services which require the pumping of large volumes of water.

Economy Pumps, Inc. writes us as follows:

> "We use the Strobotac to check speed of vertical axial flow pumps because the ends of the shafts are usually inaccessible. One end is below the floor, under water. The other is at the top of the motor, perhaps ten feet above the floor. Some shaft is exposed to view near the floor and we illuminate that with the Strobotac." (See photograph)
>
> "We also use the Strobotac for dynamic balancing of large impellers for our pumps."

Here, as in hundreds of instances, the Strobotac accurately measures the speed of moving parts inaccessible to other methods. By "stopping motion", the Strobotac flash (5 to 10 microseconds) reveals conditions and causes, effects and defects, previously hidden or obscured.

STROBOTAC

Type 631-B

Flashing Speed Range: from 600 to 14,400 per minute, calibrated to read directly in rpm. Upper speed limit: 100,000 rpm.

Flash Durations: between 5 and 10 microseconds.

Power Supply: 115 volts, 60 cycles.

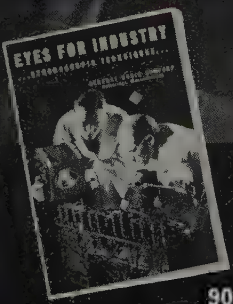
Power Input: 25 watts

Tubes: complete set furnished; also cord and plug.

Dimensions: 7½ x 8¾x 9⅞ inches.

Price: $125.00

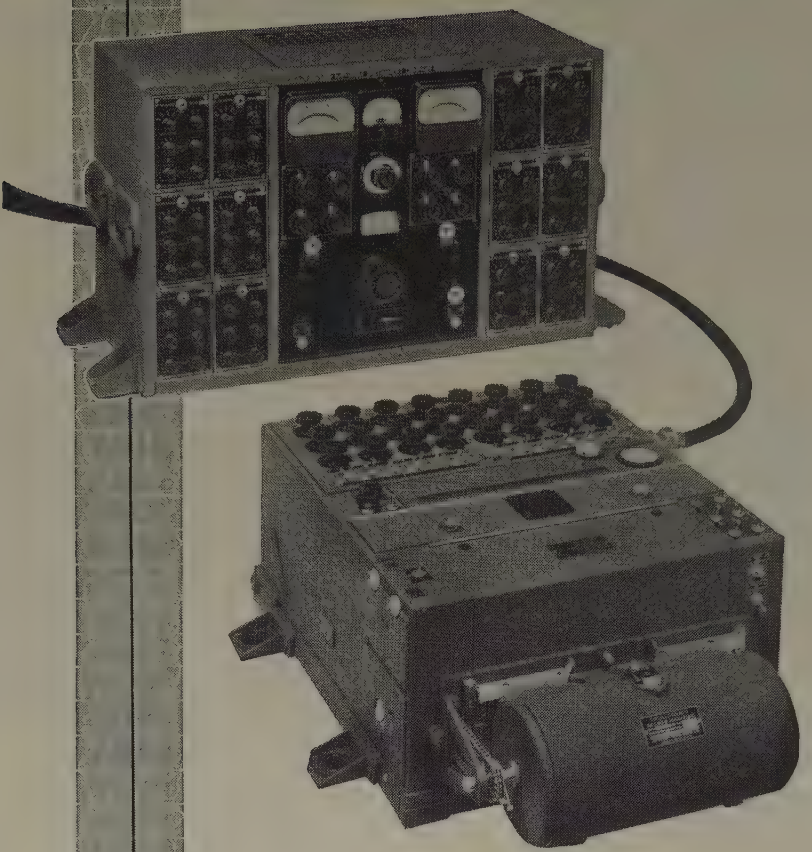
Write for your 24 page manual of stroboscopic techniques, "Eyes for Industry".



GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

Equipment for Strain Recording



Illustrated is a complete 12-channel portable laboratory for precision strain determination from static strain to a frequency of 5000 cycles per second, using resistance gages that are attached by cement to the points of strain.

In the field or in the laboratory...on a high-speed locomotive or in the air... HATHAWAY strain recording equipment is ideal for the recording of STATIC AND DYNAMIC STRAIN in structural members and machines in operation.

Complete with all necessary balancing controls and monitoring instruments, precision calibrating device, power supply equipment and oscillator, and type S8-B Oscillograph.

TYPE MRC-15 12-element Strain Gage Control Unit. Fully described in Technical Bulletin SP 195 J

Type S8-B 12- to 48-element Oscillograph Fully described in Technical Bulletin SP 165 J

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

(*Continued from page 16A*)

newly created export department of the Howell Electric Motors Company, with headquarters in the Stephenson Building in Detroit. The Howell Company manufactures a complete line of a-c motors.

Tube Experts Join Philco. Roger M. Wise, a leading authority on electron tubes, and his group of experienced tube engineers are joining the technical staff of Philco Corporation, which has recently acquired the assets of Roger M. Wise, Inc. The Wise organization will occupy new laboratories in modern plants of the Lansdale Tube Company. Among other leading engineers in the Wise firm who are joining the Philco technical staff are H. Kenneth Ishler, Joseph J. Grabiec, E. J. Hoffman, Doctor Philip Hambleton, and Stuart L. Parsons.

ASRE Appointment. D. C. McCoy, refrigeration and frozen food authority of the frigidaire division of General Motors, has been named editor-in-chief of the 1950 refrigeration applications edition of the Refrigerating Data Book, published periodically by the American Society of Refrigeration Engineers.

New York Air Brake Appointment. B. R. Teree has been appointed to the office of director of engineering of the hydraulic division at Watertown, N. Y., of The New York Air Brake Company. Mr. Teree is on the staff of the aircraft technical committee of The Society of Automotive Engineers.

Wilson Acquires Dudgeon Tube Expanders. Thomas C. Wilson, manufacturers of tube cleaning equipment, has purchased the tube expander business of Richard Dudgeon, Inc., New York, N. Y. In the future, Wilson plants will manufacture Wilson tube cleaners and Wilson-Dudgeon tube expanders, while Richard Dudgeon, Inc., will produce hydraulic machinery only.

Brehm Vice-President of Frederic Hart. Frederic Hart and Company, Inc., Poughkeepsie, N. Y., an affiliate of American Type Founders, Inc., has elected James F. Brehm as vice-president. The Hart company manufacturers electronic equipment.

Shea President of Star Electric. The Star Electric Motor Company of Bloomfield, N. J., has elected Harrie T. Shea as president, to succeed Elvin E. Hallander, who was elected chairman of the board of directors.

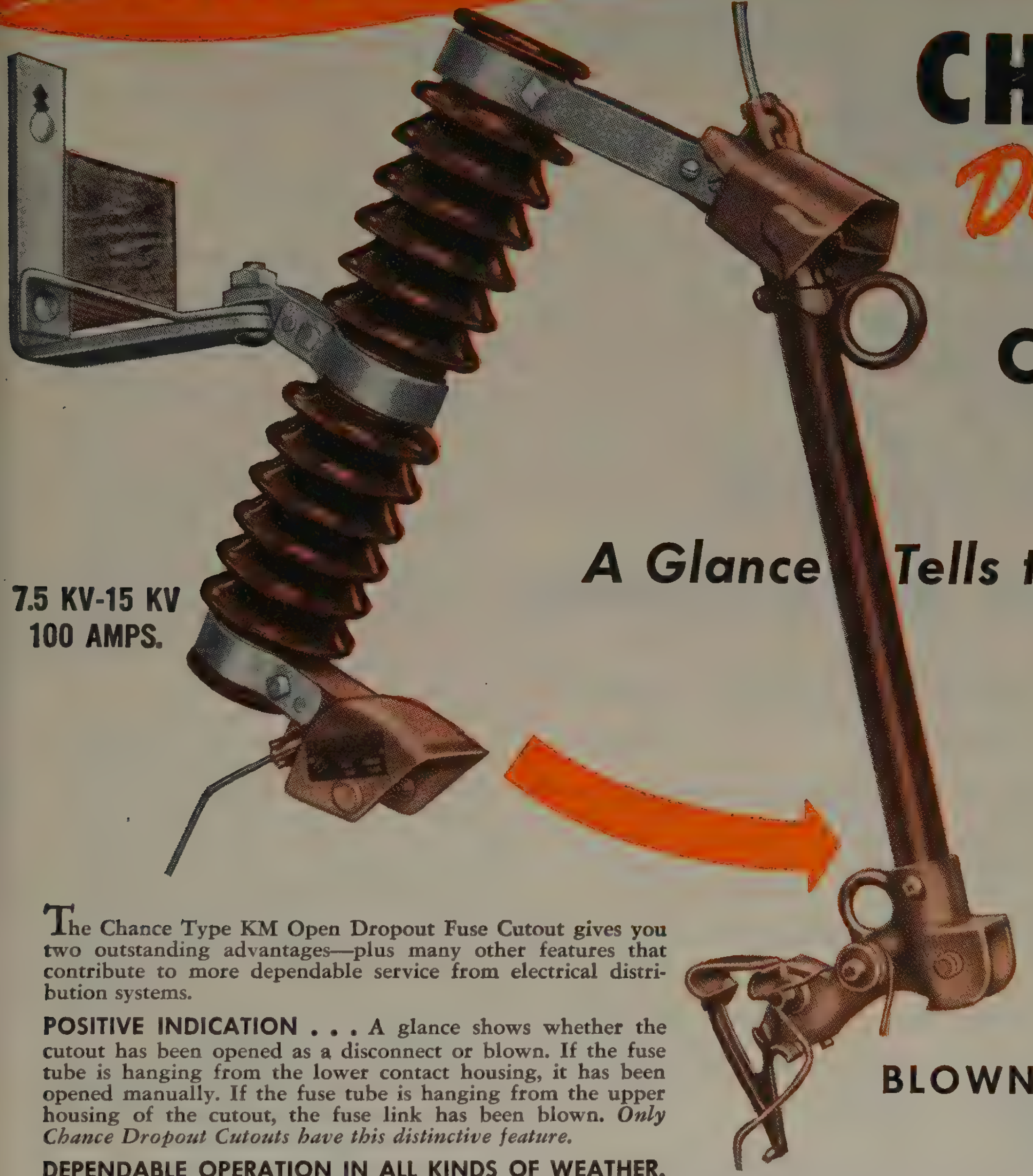
Russell Electric Appointment. W. H. Magee has been appointed general sales manager of Russell Electric Company, Chicago, Ill., a subsidiary of Raytheon Manufacturing Company.

Apex Appointment. Earl L. Bosley has been named Cleveland division sales manager for the Apex Electrical Manu-

(*Continued on page 28A*)

. . and System Protection

CHANCE
Drop Out
Fuse Cutout



A Glance Tells the Story

OPERATED MANUALLY

BLOWN BY FAULT

The Chance Type KM Open Dropout Fuse Cutout gives you two outstanding advantages—plus many other features that contribute to more dependable service from electrical distribution systems.

POSITIVE INDICATION . . . A glance shows whether the cutout has been opened as a disconnect or blown. If the fuse tube is hanging from the lower contact housing, it has been opened manually. If the fuse tube is hanging from the upper housing of the cutout, the fuse link has been blown. *Only Chance Dropout Cutouts have this distinctive feature.*

DEPENDABLE OPERATION IN ALL KINDS OF WEATHER. All working parts, at both top and bottom of the cutout assembly, are shielded from ice accumulations. When the fuse link blows, the lower end of the fuse tube swings away from the lower contact, leaving the fuse tube suspended by its closed end. This prevents moisture from entering the fuse tube.

OTHER IMPORTANT FEATURES. When the fuse tube is moved into the closed position, fuse link is not subjected to shock or additional tension causing premature failure. Fuse tube is not subjected to compression stresses or warping when in the closed position.

Pressure contact springs are protected by over-travel stops and wipe contacts clean when fuse tube is installed.

When the fuse link melts, the fuse link leader is quickly drawn out of the tube by an ejector arm which does not lose contact with the clip until it has completed its operation. This operation is delayed during short circuit, reducing the possibility of contact pitting.

Fuse tube may be provided with an attachment which will prevent the fuse leader being thrown from the cutout during a short circuit operation.

when you specify...

A·B·CHANCE CO·

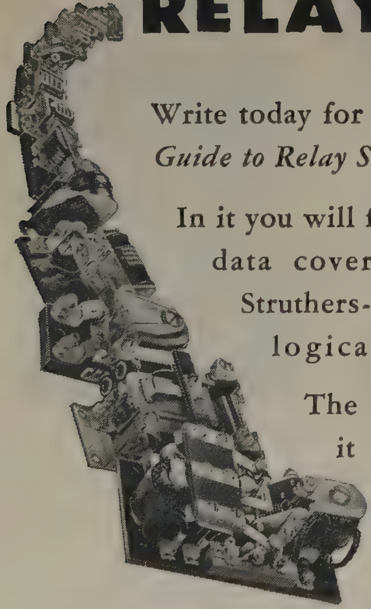
ELECTRICAL TRANSMISSION & DISTRIBUTION EQUIPMENT
FOR CONSTRUCTION, MAINTENANCE & OPERATION

AN FRANCISCO, CALIFORNIA

YOURS for the asking!

Simplifies

RELAY SELECTION!



Write today for your copy of this new *"Quick Guide to Relay Selection"*!

In it you will find condensed and simplified data covering the most widely used Struthers-Dunn relays and timers listed logically according to function.

The whole idea has been to make it easy for you to select exactly the right relays for your applications.

ASK FOR CATALOG G.

STRUTHERS-DUNN

STRUTHERS-DUNN, INC., 150 N. 13th Street, Philadelphia 7, Pa.

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DENVER • DETROIT • INDIANAPOLIS • KANSAS CITY • LOS ANGELES
MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PHILADELPHIA • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

(Continued from page 20A)

facturing Company, Cleveland, Ohio. Prior to the Apex appointment, Mr. Bosley was sales manager for Northern Ohio Appliances.

Hall Boston Manager of Amphenol. Richard E. Hall has been assigned to the Boston office of the American Phenolic Corporation to cover the New England area. Mr. Hall succeeds the late Morrill P. Mims, who represented the American Phenolic Corporation in New England until his death in December, 1948.

NEW PRODUCTS • • •

Askarel-Filled Capacitors. The Moloney Electric Company, St. Louis, Mo. has announced the addition of single-phase, Askarel-filled capacitors to their line of transformers. They are available in 15 and 25 reactive kva sizes and in all voltage ratings from 2400 volts through 13,800 volts. The new capacitors meet all E.E.I.-NEMA (Edison Electric Institute-National Electrical Manufacturer's Association) standards. Further information may be obtained from the company.

General Radio Developments. A new line of basic unit-type laboratory instruments has been developed by the General Radio Company, 275 Massachusetts Avenue, Cambridge, 39, Mass., which are designed to be versatile in application and lower in price than more elaborate types. They are especially suited for student use. Three units are now available: a 3-watt amplifier of 45-decible gain, covering the range from 20 cycles to 200 kc; an oscillator, with plug-in tuning units operating from 400 cycles to 80 megacycles; and a small, compact a-c power pack that plugs into either the oscillator or the amplifier. Another development at General Radio is type 1612–A R–F capacitance meter, which is designed for rapid measuring and testing of small capacitors (up to 1200 micromicrofarads) such as those used in radio-frequency equipment. The instrument operates from a 115-volt power line, either a-c or d-c. Weight is 11 pounds. For further information, write directly to the General Radio Company.

Nolan Melting Furnace. The Nolan Corporation, 1333 East Dominick Street, Rome, N. Y., has announced manufacture of a new Metal ReMelter, a complete metal melting furnace for babbitt, solder, lead or wax and insulating compounds. Two standard models, square in design, are offered the Nolan "2000" which has a one-ton capacity metal pot, and the Nolan "650" which has a 650-pound capacity metal pot. They may be equipped for heating by electricity, oil, or any type of gas. Descriptive bulletins upon request.

Ge Tube Analyzer, Motor Construction Kit. A new type of electronic tube analyzer developed by the specialty division of

(Continued on page 42A)

YOU ITS HANDY, NEW

RM* HANDYLOG

A valuable new money-saving, time-saving convenience for purchasers of power insulators and supension hardware

Lists...in just 32 pages...all the power insulators and suspension hardware products you need for handling over 95% of your jobs

Use coupon below to bring Locke's RM* HANDYLOG to your desk

Place the items you find in it on your standards list and you'll obtain five important advantages—

1. **YOU SIMPLIFY STOCKS** and stocking operations because RM items . . . by having the ability to do a number of jobs equally well . . . should enable you to reduce your stocks to a new low.
2. **YOU PAY LOWEST PRICES** for RM items because they are all standard items . . . produced in large quantities.
3. **YOU GET PROMPT SERVICE** on RM items because they're always carried in stock by your Locke Regional or Distributors warehouse.
4. **YOU GET FAST DELIVERY** on RM items because they are always being produced . . . always on hand for immediate shipment from the factory.
5. **YOU REDUCE CHANCES OF OBSOLESCENCE** using RM items because their assured availability allows you to match future extensions to present construction.

***RM (Repetitive Manufacture)**
A Program designed to help reduce the installed cost per kilowatt on line and station equipment.

LOCKE
INCORPORATED
BALTIMORE, MARYLAND

LOCKE INCORPORATED • BALTIMORE, MARYLAND
MAIL THIS COUPON FOR YOUR RM* HANDYLOG

Name ________________

Title ________________

Company ________________

Address ________________

____

before you buy.. stop! see what LOCKE'S got...

(*Continued from page 28A*)

the General Electric Company at Electronics Park, Syracuse, N. Y., specifically for use with thyratron and phanatron tubes is now available. The new unit, type YTW-3, measures the peak arc drop voltage of thyratrons and phanatrons under maximum or specific application load. Further information on the industrial tube analyzer may be had by writing to the company at the above address. Another development at General Electric is a new line of fractional-horsepower motor construction kits for use as teaching aids in school shops and laboratories. Each kit contains the necessary components for assembling a full size regulation motor, available in four sizes: 1/4- and 1/2-horsepower single-phase capacitor-start type; 1/2-horsepower 3-phase, and a d-c unit suitable for use as a 300 watt generator or 1/2-horsepower motor. For further information on the kit, write to the Educational Section, General Electric Company, Apparatus Department, Schenectady 5, N. Y.

New Control Transformers. The Industrial Controller Division of the Square D Company, 4041 North Richards Street, Milwaukee 12, Wis., has introduced a line of control circuit transformers, class 9070 Type *A*, designed specifically for use with industrial control equipment which is characterized by high, momentary inrush currents to the a-c operating magnet coils. To provide secondary circuit protection, either one or two fuse and bracket assembly units can be easily mounted directly on the transformer. Sizes available in 50, 100, 150, 300 volt-amperes at either 50/60 or 25 cycles, and 500 volt-amperes at 50/60 cycles, with primary voltages of 220-440 (dual voltage), 550, 440, 380, and 220, and secondary voltages of 110 or 24 volts. For additional information, write for bulletin number 215, directly to the company.

Ball-Tilting Milling Table. The Leo G. Brown Engineering Company has introduced a new milling table, made from mechanite semi-steel normalized castings, with hand engraved calibrated dials. The ball will tilt 30 degrees any angle; rotary base calibration 360 degrees. For additional information, contact the Leo G. Brown Engineering Company, 1531 South Sunol Drive, Los Angeles 23, Calif.

Service Entrance Cable. United States Rubber Company, Rockefeller Center, New York 20, N. Y., has developed a new long-wearing service entrance cable for carrying electricity from main power lines to homes, offices, and industrial buildings. The cable has a natural rubber insulation around its conductors and an outside jacket made of neoprene, which will eliminate festooning, or the separation of the outside braid from the cable. Write to the company for any additional information.

Portable Instruments. The Weston Electrical Instrument Corporation has announced a new series of a-c and d-c portable instruments, designated the model 901 series, which are available as d-c volt-meters, volt-ammeters, ammeters, milliameters, and microammeters. The instruments are shielded against external magnetic fields. Another development at Weston is a new industrial integrator, model 808, which provides means for simple and effective integration of d-c potentials or currents with respect to time. An electronic relay circuit, Weston model 806, is the primary element, operating the relay circuit to initiate an oscillatory action, the frequency of which is proportional to the input. The counter totalizes the number of cycles, to provide a running time-integral of the input. Unlimited service life may be expected. Literature may be secured on both these instruments by writing to the Weston Electrical Instrument Corporation at 617 Frelinghuysen Avenue, Newark 5, N. J.

Automatic Timer. A unit for the automatic timing of continuous processing work where the various process periods bear a percentage relationship to the total time cycle has been introduced by Struthers-Dunn, Inc., 150 N. 13th Street, Philadelphia 7, Pa. It consists of a synchronous motor operating through an adjustable drive to move a control arm radially around a calibrated scale. Speed range is in the ratio of 36 to one. For additional information, write for Struthers-Dunn data section 7110.

(*Continued on page 46A*)

PIPE THREAD BUSHINGS

Universal insulated bushings are made accurately and within close dimensional tolerances, even when used as part of a metal assembly. They are black glazed, dry process porcelain, with perfect thread fit for steel conduit locknuts.

Offered in 3 sizes to fit standard ¼", ⅜" and ½" conduit, ½" size available with 7/16" hole (standard) or ½" hole if specified, at no extra cost.

AVAILABLE FOR IMMEDIATE DELIVERY

with or without steel locknuts.

Send sample or dimensional drawings for quotation.

THE UNIVERSAL U CLAY PRODUCTS CO.
1560 EAST FIRST STREET SANDUSKY, OHIO
TRADE MARK

STEP DOWN TRANSFORMERS

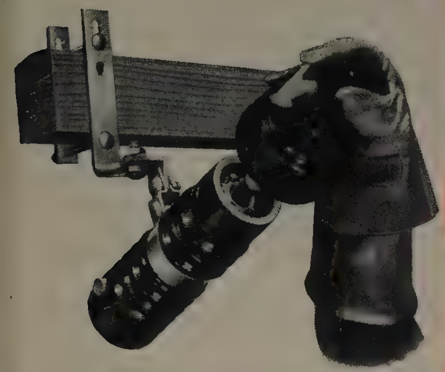
Whenever you need a 110/115 volt, 60 cycle current supply but have only 200/240 volt, 60 cycle available, use an Acme Electric Step Down Transformer. 75 to 1000 watt capacities have primary cord to plug into line and secondary plug receptacle. 2000 and 3000 watt capacities available with conduit knockouts.

Write for Bulletin SD151.

ACME ELECTRIC CORPORATION
225 WATER STREET CUBA, N. Y.

Acme ACME Electric

dopted the NEW POSITECT



TYPICAL PERFORMANCE VALUES

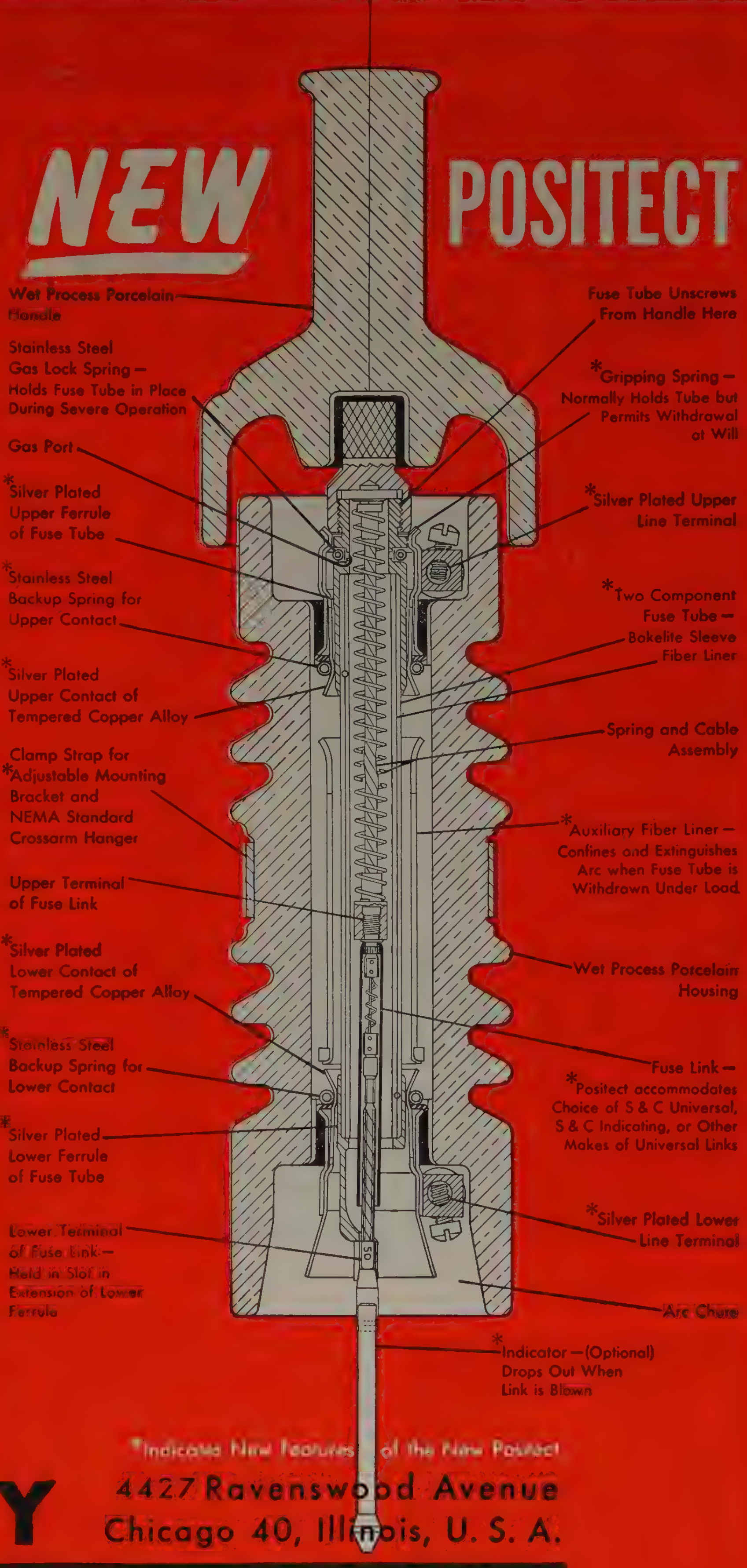
Short Circuit Interrupting Capacity
of 10,000 and 12,000 amperes for the 50-ampere and 100-ampere Positect respectively, on 2400-, 2400/4160y- and 4800-volt systems.

Load and Magnetizing Current Interrupting Ability
adequate for switching: 75 kva single-phase distribution transformers on 2400- and 2400/4160y-volt systems, with the 50-ampere Positect; 100 kva single-phase, with the 100-ampere Positect; also 3-phase transformers of corresponding load current values.

Charging Current Interrupting Ability
adequate for switching 3-phase capacitor banks up to 135 kvar on 2400-volt systems, and 225 kvar on 2400/4160y-volt systems, with 50-ampere Positect; with the 100-ampere Positect, 225 kvar on 2400-volt systems.

RATINGS

5000 Volts, 50 Amperes
5000 Volts, 100 Amperes
7500 Volts, 50 Amperes


Wet Process Porcelain Handle
Stainless Steel Gas Lock Spring — Holds Fuse Tube in Place During Severe Operation
Gas Port
*Silver Plated Upper Ferrule of Fuse Tube
*Stainless Steel Backup Spring for Upper Contact
*Silver Plated Upper Contact of Tempered Copper Alloy
Clamp Strap for *Adjustable Mounting Bracket and NEMA Standard Crossarm Hanger
Upper Terminal of Fuse Link
*Silver Plated Lower Contact of Tempered Copper Alloy
*Stainless Steel Backup Spring for Lower Contact
*Silver Plated Lower Ferrule of Fuse Tube
Lower Terminal of Fuse Link — Held in Slot in Extension of Lower Ferrule
Fuse Tube Unscrews From Handle Here
*Gripping Spring — Normally Holds Tube but Permits Withdrawal at Will
*Silver Plated Upper Line Terminal
*Two Component Fuse Tube — Bakelite Sleeve Fiber Liner
Spring and Cable Assembly
*Auxiliary Fiber Liner — Confines and Extinguishes Arc when Fuse Tube is Withdrawn Under Load
Wet Process Porcelain Housing
Fuse Link — *Positect accommodates Choice of S & C Universal, S & C Indicating, or Other Makes of Universal Links
*Silver Plated Lower Line Terminal
Arc Chute
*Indicator — (Optional) Drops Out When Link is Blown
50

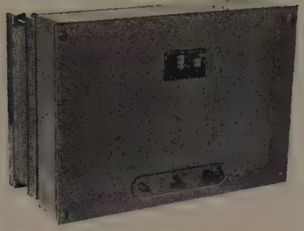
*Indicates New Features of the New Positect

COMPANY

4427 Ravenswood Avenue
Chicago 40, Illinois, U. S. A.

Formerly SCHWEITZER & CONRAD, INC.

the first line of **standard** electronic voltage regulators



Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under SIMULTANEOUS line and load changes.

SIX IMPORTANT SORENSEN FEATURES:

1. Precise regulation accuracy;
2. Excellent wave form;
3. Output regulation over wide input voltage range;
4. Fast recovery time;
5. Adjustable output voltage, that once set, remains constant;
6. Insensitivity to line frequency fluctuations between 50 and 60 cycles.

The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

SORENSEN and company, inc.
375 fairfield avenue, stamford, connecticut

RECOMMENDED PRACTICE FOR

Electric Installations on Shipboard

(MARINE RULES)

No. 45
AIEE Standards

THE latest edition of "Recommended Practice for Electric Installations on Shipboard" (Marine Rules) is published as Section 45 of the AIEE Standards. The pamphlet contains 150 pages; price is $3.50 (50% discount to members of the AIEE on single copies).

New Edition
December 1948

These Rules have been drawn up to serve as a guide for the equipment of merchant ships with electric apparatus for lighting, signaling, communication, power and propulsion for both alternating and direct current systems. They indicate what is considered good engineering practice with reference to safety of the personnel and of the ship itself, as well as reliability and durability of the electric apparatus.

American Institute of Electrical Engineers

33 West Thirty-Ninth Street, New York, 18

5–49

(Continued from page 42A)

A-C Servo Motors. The Kollsman instrument division of the Square D Company has developed a 400-cycle 115-volt 2-phase 4-pole induction a-c servo motor with a torque to inertia ratio of 26,300 radians per second per second. It is possible for the motor to reverse fully in two-tenths of a second from 11,200 rpm. It delivers $2^{1}/_{3}$ ounce-inches stall torque which varies directly with the control winding voltage, and will stop rotating when the excitation of the control winding is reduced to zero. It is especially adaptable to the high performance servo systems. For applications where higher acceleration is more important than small size and light weight, another new Kollsman servo motor has been developed, a four pole motor, and its torque to inertia ratio is 46,000 radians per second per second, with a stall torque of 3.8 ounce-inches. Address requests for further information to the Kollsman Instrument Division of Square D Company, 80-08 45th Avenue, Elmhurst, New York.

TRADE LITERATURE

Tailor-Made Irons. The Frank Foundries Corporation of Moline, Ill., manufacturers of "Frankite" electric furnace-made alloyed tailor-made gray irons, have issued a 32-page booklet in commemoration of their 50th business year, which describes their product, and the many ways in which it is used. The booklet, "50th Anniversary" is available upon request.

Metco News. Published bimonthly by the Metallizing Engineering Company, Inc., 38-12 30th Street, Long Island City 1, N. Y., *Metco News* contains briefs from industry on proved applications of metallizing and recommended methods. The most recent copy, volume 4, number six, contains a discussion on roll maintenance. Company will supply copies upon request.

Lathe Attachment Catalogue. South Bend Lathe Works has issued a new machine tool attachment and accessory catalogue, number *77-U*, which contains illustrations and specifications of items which will make possible a wider range of work on lathes and drill presses. For a copy, write to the South Bend Lathe Works, South Bend 22, Ind.

Soldering Tips. Designed to instruct beginners and refresh the memories of experienced solderers, a booklet, "Soldering Tips," published by the Weller Manufacturing Company, takes the reader step-by-step through the entire soldering process in 20 illustrated pages. The booklet may be obtained by sending ten cents in coin directly to the Weller Manufacturing Company, Packer Street, Easton, Pa.

Electromagnetic Controls Catalog. Automatic Switch Company of 391 Lakeside Avenue, Orange, N. J., has issued a new

(Continued on page 52A)

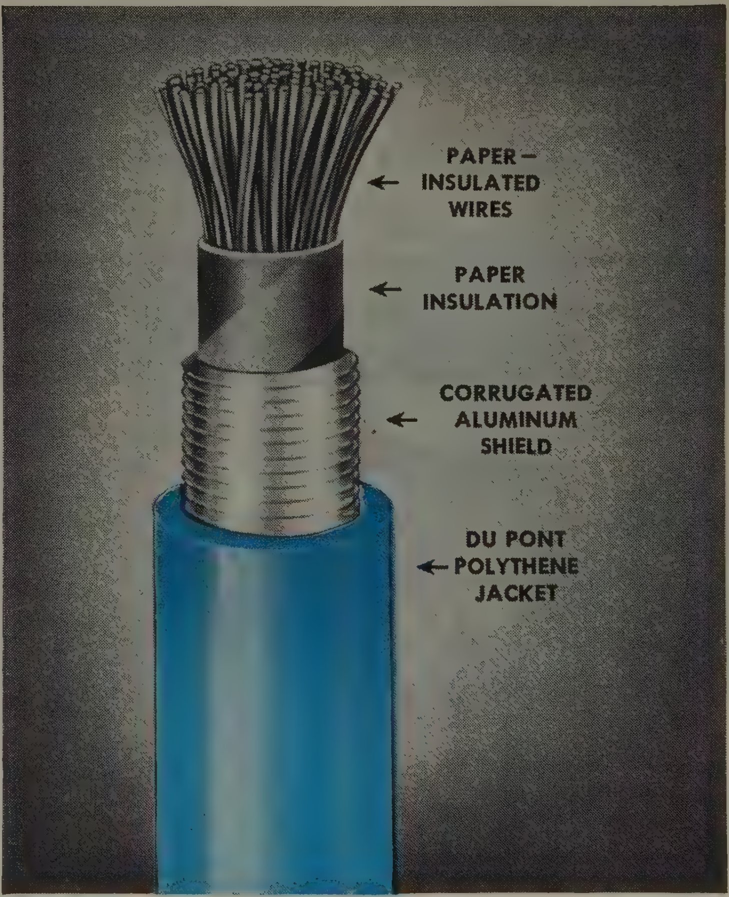
DU PONT POLYTHENE PLASTIC HELPS TELEPHONE ENGINEERS SOLVE TOUGH PROBLEM

New Jacket of Polythene and Aluminum is used as Shield on Telephone Cable

The shortage of lead for telephone cable sheathing was solved recently, after some years of research, by engineers of Bell Telephone Laboratories and Western Electric. They found an economical answer in a jacket of a new plastic, Du Pont polythene . . . extruded over an aluminum shield.

Polythene was chosen because of its mechanical properties, resistance to many chemicals, resistance to weathering when properly compounded, and ease of extrusion. And the moisture-resistance of the polythene-aluminum combination is excellent.

NEW WESTERN ELECTRIC CABLE CONSTRUCTION



"Alpeth" cable shown above, a joint development of Bell Telephone Laboratories and Western Electric Company, is now being manufactured by Western Electric.

ELECTRICAL ENGINEERS FINDING MANY NEW USES FOR DU PONT POLYTHENE PLASTIC

The use of polythene in telephone cables follows its widely accepted use in many other types of electrical equipment. In one current application, polythene is used to mold the potential coil to the electromagnet core of a new watt-hour meter. Polythene provides greater insulation strength, reliability . . . and extra-long life for this potential coil.

Polythene molding powders may be injection- or compression-molded . . . extruded as sheeting, tubing, or wire-covering. They are available in a range of colors. The demand for polythene still exceeds the supply, but continuing increases in production are being pushed to meet this situation.

Facts about properties of Du Pont polythene and examples of current use may be obtained by writing E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Empire State Building, 350 Fifth Avenue, New York 1, New York; 7 South Dearborn Street, Chicago 3, Illinois; or 845 East 60th Street, Los Angeles 1, California.

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... THROUGH CHEMISTRY

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Papers, Fibres
Silicones
Sleevings
Tapes
Tubings
Varnishes

If you have a *special* electrical insulation problem — heat, moisture, oil, acid, etc. — which causes persistent trouble — *that's* where we shine. For years and years we have studied the problems of the man who has more than the ordinary insulation problem. We have found ways to lengthen insulation life under adverse conditions. We developed Mica-Glas, all-inorganic. We were among the first to apply the advantages of silicone to insulation. Then, to bring such experience to you we placed factory-trained engineers in the field. One is near you *now*, waiting not just to sell insulation but to help you profit by its use. Use him. Tell him your problem. He's equipped to solve insulation problems, and that's his job. Call him in; if you don't know him, write or wire us.

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COLUMBUS 16, OHIO, U. S. A.
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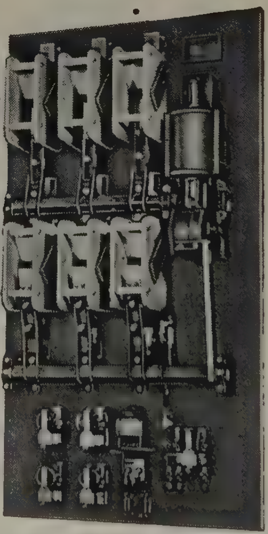
TRADE MARK

HEADQUARTERS FOR AUTOMATIC TRANSFER SWITCHES...



We can take care of almost any Automatic Transfer Switch requirement ranging from 5 to 1000 amperes. For example, Bulletin 906-105S, as illustrated, is a 300 ampere unit installed in a specially narrow panel for a distribution control center

Standard features on control panels can include phase failure protection, indicating auxiliary contacts, engine starting contacts and push buttons for engine tests, reset to normal and load transfer. Special features include delayed operation, manual emergency handles, low frequency relay protection. Condensed Catalog No. 700 gives a comprehensive picture of our work along the line of Automatic Transfer Switches and complete Electromagnetic Control Panels.

If you require any type of automatic control, write us Our 60 odd years of broad experience in the field of Electromagnetic Controls should be helpful.

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Remote Control Switches
Contactors Relays
Specialized Electromagnetic Controls

We also manufacture a complete line of Solenoid Operated Valves for Automatic and Remote Control of Liquids and Gases.

ASCA Electro-Magnetic CONTROLS

Automatic Switch Co.
385-E LAKESIDE AVENUE · ORANGE, NEW JERSEY

(*Continued from page 46A*)

condensed catalogue, number 700, which describes "specific purpose" controls made by that company. The purpose of the catalogue is to demonstrate how the company can meet any particular requirements of any engineer, contractor, or manufacturer. Copies are available upon request to the company.

Multiplex Pumps. Byron Jackson lines of *SD* and *SDO* multiplex pumps, centrifugal, multistage, split case, and volute type, designed for medium and high-pressure service, are described in a 16-page booklet supplied upon request. Both types are made as two, four, six, and eight stage units with heads to 2,000 feet and capacities from 100 to 4,000 gallons per minute. Write for bulletin number *48-4000*, to Byron Jackson Company, Pump Division, Terminal Annex Box 2017, Los Angeles 54, Calif.

Reliance A-C Motors. The latest available selection data on The Reliance Electric and Engineering Company's precision built a-c motors has been presented in a new 8-page booklet, *B-2101*. Copies of the bulletin may be had by writing to the company's sales promotion department, 1076 Ivanhoe Road, Cleveland, Ohio.

Handbook of "U" Values. Silvercote Products, Inc., 161 East Erie Street, Chicago 11, Ill., have made available a 108-page handbook which, for the first time, includes summer as well as winter "U" (insulation) values. It lists 12,852 certified, F. H. A. approved "U" values of various walls, floors, and ceilings; coefficients, and 238 drawings. Copies of the new handbook (previously sold for $1.00) are available free of charge upon request by qualified architects, engineers, and builders, by writing to Silvercote Products.

Pole-type Capacitors' Bulletin. Cornell-Dubilier Electric Corporation of South Plainfield, N. J., has issued a new bulletin on pole-type capacitors, giving construction data, and other pertinent information. Copies of catalog number 145PF may be obtained by writing to the power factor division of the Cornell-Dubilier Electric Corporation.

GE Publications. "The Purpose and Use of Electrical Diagrams Supplied With G-E Switchgear Equipment," bulletin GET-1293A is a functional 24-page booklet designed to assist any user of GE switchgear to further understand the purpose of certain parts or arrangements of the equipment. Diagrams illustrated are one-line, elementary, connection, and interconnection. Another recent publication issued by the company is a 20-page illustrated bulletin, GET-922-B, which gives complete information on the installation, operation, and testing of ballasts for fluorescent lamps. The bulletin was compiled by the company's specialty transformer and ballast divisions. Both booklets mentioned above are available by writing to the General Electric Company, Schenectady 5, N. Y.

HIGHLIGHTS........

Institute Policy. In view of many recent controversies, the question of whether the Institute should limit itself, as a strictly scientific and educational organization, to purely technical activities, or whether it also should concern itself with nontechnical activities was discussed at the recent meeting of the Board of Directors in Dallas, and a resolution favoring the former stand was offered for study (*pages 545–6*). Before making a final decision, however, the Directors wish to obtain the opinions and desires of the membership. The situation is reviewed in this issue (*page 536*).

Summer General Meeting. With headquarters at the New Ocean House in Swampscott, Mass., on Boston's North Shore, this year's Summer General Meeting, June 20–24, offers another splendid opportunity to combine an interesting and informative technical meeting with a delightful vacation (*pages 537–40*).

Committee Notes. The new department, "Committee Notes," which was initiated with the April issue, presents a number of short items reporting the plans and activities of various technical committees (*pages 548–50*).

Digests. A number of technical papers presented at the 1949 AIEE Winter General Meeting in New York, N. Y., January 31–February 4, are included in this issue in one-page digest form (*pages 477, 478, 489, 490, 491, 502, 503, 504, 511, 512, 520*).

Electron Tube Conference. More than 238 persons were attracted to the AIEE Conference on the Industrial Application of Electron Tubes which was held at the Hotel Statler, Buffalo, N. Y., April 11–12, 1949 (*pages 540–1*). The program presented some 20 papers covered in four sessions. Authors' digests of most of these papers are included in this issue (*pages 525–9*).

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South West District Meeting. Built around the theme, "What Electrical Engineers Are Doing to Meet the Needs of the Growing Southwest," the AIEE South West District Meeting was held April 19–21 in the city of Dallas, Tex. (*pages 541–5*). Authors' digests of most of the District papers presented at the program's ten technical and general sessions appear in this issue (*pages 529–34*).

Engineering Internship. Law, medicine, the ministry, and teaching all have recognized the importance of a period of transition from theory to practice and have definitely established such a period as prerequisite to practice in the profession. The necessity for incorporating a period of "internship" into the engineering profession also is upheld by the author, who points out that too often the young engineering graduate is expected to solve practical problems immediately without an opportunity to gain practical experience (*pages 485–8*).

The Brain as a Computing Machine. The brain, according to this article, is a digital computing machine consisting of ten billion relays called neurons. However, it is much the most complicated of the computing devices. A large building could not house a vacuum tube computer with as many relays as a man contains in his head and "it would take Niagara Falls to supply the power and Niagara River to cool it" (*pages 492–7*).

Ferromagnetism. Recent advances in the theory of ferromagnetism are explained in this article. It deals with the subjects of domain structure and domain geometry, fine particles with high coercive force, and ferromagnetic resonance at microwave frequencies (*pages 471–6*).

Traction Motors. Great progress has been made in the past 25 years in the design of traction motors; a primary object is to achieve weight reduction. Developments in bearings, gearing, commutator and armature construction, ventilation, insulation, methods of frame manufacture, and electrical design have contributed to this progress (*pages 479–85*).

AIEE Proceedings

Order forms for current AIEE *Proceedings* have been published in *Electrical Engineering* as listed below. Each section of AIEE *Proceedings* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *Transactions*.

AIEE *Proceedings* are an interim membership service, issued in accordance with the revised publication policy that became effective January 1947 (*EE, Dec '46, pp 567–8; Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *Proceedings* will appear in *Electrical Engineering* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter General (1948)
Aug '48, p 45A	Great Lakes District North Eastern District Summer General
Oct '48, p 43A	Pacific General Middle Eastern District
Dec '48, p 35A	Midwest General Southern District
Apr '49, p 25A	Winter General (1949)

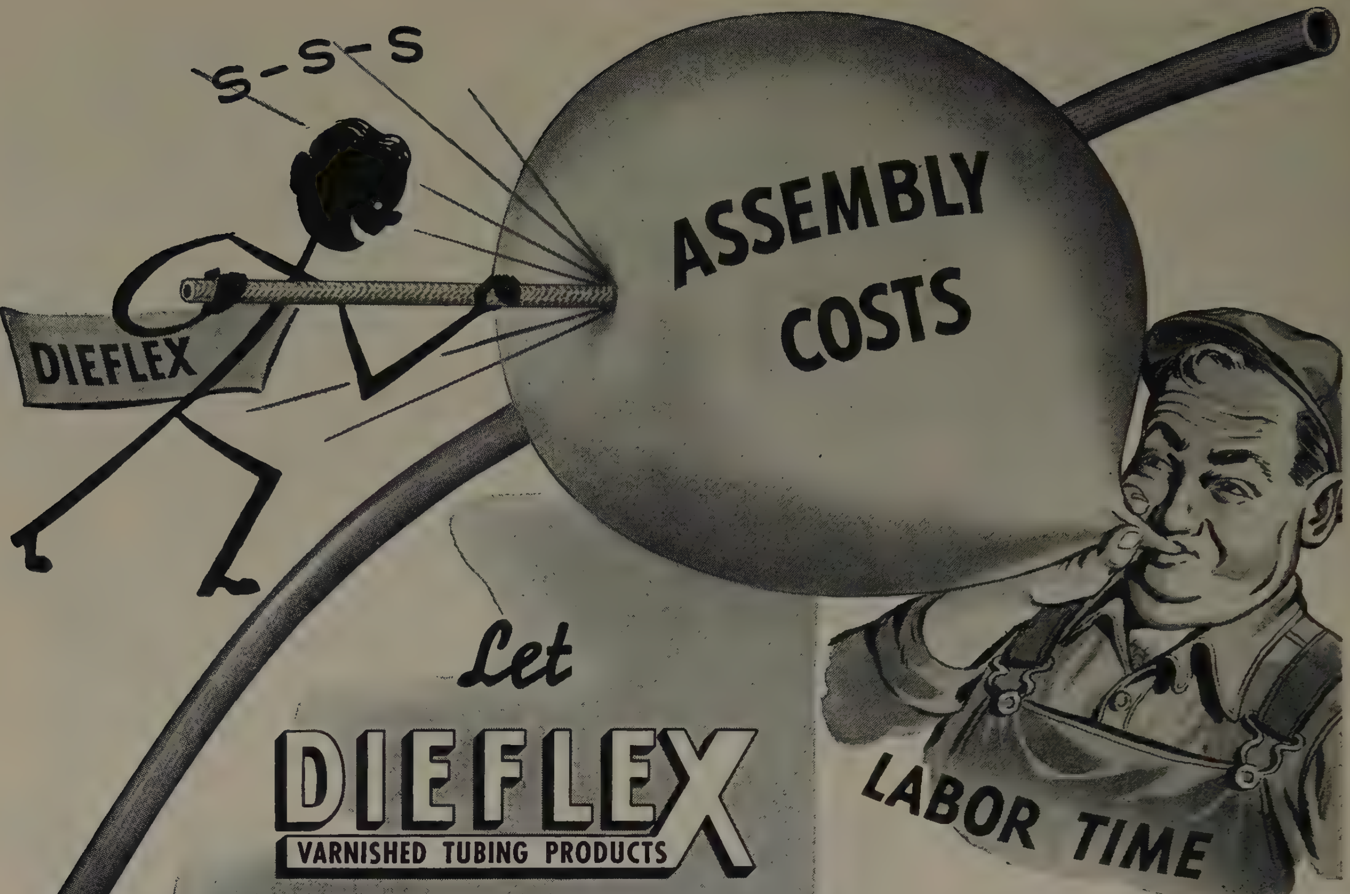
Television Receiving Systems. The televising of events like the World Series, the heavyweight fights, and the political conventions has helped to create such a public demand for popular priced television receivers that "the growth of television during the past year has exceeded the most optimistic postwar predictions." This article discusses both direct viewing and projection receivers (*pages 513–17*).

Gas Turbines. This article outlines the status of gas turbine development, describes the two types of power plants resulting from this development to date, and gives many other applications to which the units may be adopted (*pages 497–501*).

Multifrequency Pulsing. This article describes "a form of signaling with alternating currents which permits the rapid transfer over telephone trunks of the information required to select switch paths in local, toll, and tandem dial telephone systems." The first multifrequency pulsing system was installed in Baltimore, and since then many more have been installed throughout the country (*pages 505–10*).

Steam Turbines. Maintaining proper system frequency, despite large and rapid load fluctuations, has been considered an electrical problem; however, these load fluctuations affect the turbine in many ways. This article describes recent turbine designs and tells how they can more easily withstand these load changes (*pages 521–4*).

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office 20th & Northampton Streets, Easton, Pa. Editorial and advertising offices 500 Fifth Avenue, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which the second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Easton, Pa., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925.
June 1949, Vol. 68, No. 6. Number of copies of this issue 51,500



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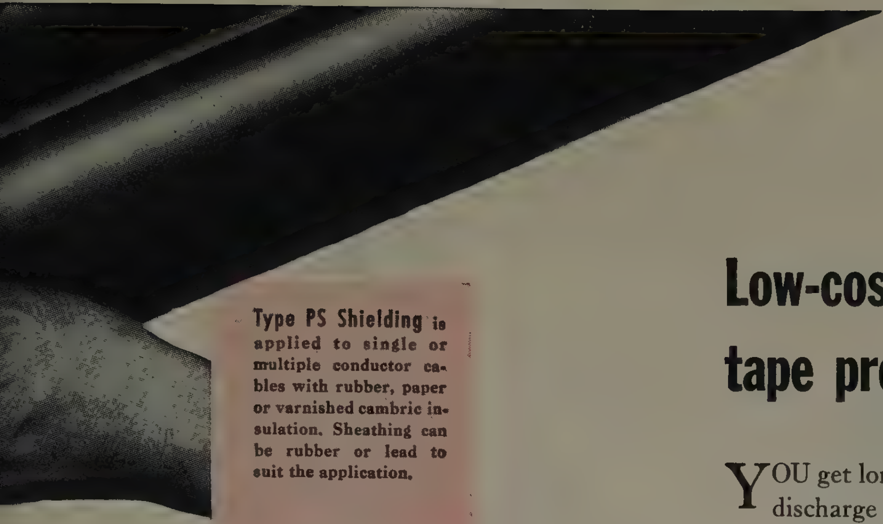

Type PS Shielding is applied to single or multiple conductor cables with rubber, paper or varnished cambric insulation. Sheathing can be rubber or lead to suit the application.

power cables

Low-cost conducting rubber tape proves highly effective

YOU get longer trouble-free life plus elimination of static discharge when Type PS Shielding is used on rubber insulated cables operating at over 2000V. For rubber cables this low-cost shielding consists of a fibrous tape coated with conducting rubber, vulcanized to the surface of the insulation. Such a tape may be used over the stranded conductor for protection against internal corona and over the outer surface in contact with the usual shielding tape, ground wires or conducting sheath. The tape eliminates any air gaps between insulation and conducting element as it becomes bonded to the insulation during vulcanization.

Type PS Shielding remains flexible . . . is superior to metal shielding which tends to separate slightly from the insulation when the cable is bent and straightened. This forms air gaps . . . causes a spark discharge with corona and ozone formation.

Type PS Shielding with conducting rubber is a development of the American Steel & Wire Company. It proved so successful that other cable companies have been licensed to use the same construction. The main applications are for portable power cable, for aerial distribution lines, and for heavy power cable wherever voltage discharge will cause damaging corona and television interference.

The safety features of the grounded tape make PS Shielded Cable ideal for use in mines and other hazardous locations. PS Shielding has been applied to both single and multiple conductor cables which are sheathed to meet various applications. Write for complete information.

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Silicone News

DC SILICONES

Silicones Pay Off In a Buyer's Market

Your customers are demanding more for their money. Offer them better performance, longer life, greater reliability or reduced maintenance costs and they'll listen. Design all four of those basic sales appeals into your product and they'll buy. You can do that in many cases by taking advantage of the exceptional stability of Dow Corning Silicones.

For example, you can give your customers permanent lubrication by using DC 44 Silicone Grease. DC 200 Silicone Fluids enable you to design more compact hydraulic systems or make wider use of viscous damping. You can increase the power per pound ratio in electric machines by 50 to 100 per cent and you can increase the life of electrical equipment by a factor of 10 through use of Dow Corning Silicone—Class "H"—Electrical Insulation.

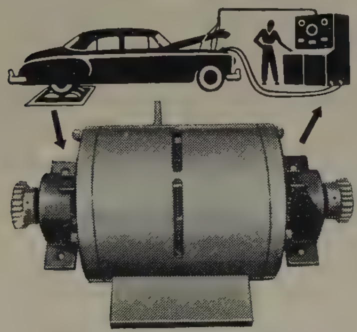

PHOTO COURTESY THE ELECTRIC PRODUCTS COMPANY

DC Silicone Electrical Insulation and DC 44 Silicone Grease improve the performance, cut maintenance and increase the life of E. P. Electric Chassis Dynamometers.

Typical application for Dow Corning Silicone Electrical Insulation is the Electric Chassis Dynamometer made by The Electric Products Company of Cleveland. Complete performance testing of automobile engines without actual road tests makes it necessary for the armature coils to absorb so much energy that operating temperatures are in the range of 400° F. Under such severe conditions, only Silicone Insulation and DC 44 Grease give long and trouble-free service.

Among many other applications, Silicone Insulation is used in building compact, high powered solenoids; portable welding transformers; bus generators and industrial motors. For more information about Dow Corning Silicone Electrical Insulation, write for pamphlet G11A6.

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INDUSTRIAL NOTES ....

President of Copperweld Steel Dies. S. E. Bramer, president of the Copperweld Steel Company, Glassport, Pa., died recently. Mr. Bramer helped to organize the company in 1915; he has been its president for the past 20 years.

Rome Cable Awarded Citation. Rome Cable Corporation, Rome, N. Y., has received the first annual award for health achievement in industry to be given by the American Association of Industrial Physicians and Surgeons. The award, in the form of a plaque, was given to the company because of the inauguration, in 1948, of a fully equipped and ably staffed medical department for its employees. The department, under the direction of Dr. James H. McDonough, gives to all employees a complete physical examination at least once a year, and provides for handling industrial injuries and emergency care of non-occupational injuries and illnesses.

G. G. Main, Westinghouse Treasurer. George G. Main of the Westinghouse Electric Corporation, Pittsburgh, Pa., has been elected treasurer, to succeed the late L. H. Lund, who died in March.

Okonite News. The Okonite Company, of Passaic, N. J., has appointed three new vice presidents: I. W. Borda, who will continue as manager of the Pacific coast district; W. R. Van Steenburgh, manager of the northeast sales district; and Stephen A. Wilson, who will continue in the capacity of secretary and general counsel. The Okonite Company has also opened a new office in Dallas, Tex., at 1505 Tower Petroleum Building, with Otis W. Herring as manager. Sam K. Dick, Okonite's Texas representative for the past 20 years, will assist Mr. Herring.

Stohr of Allis-Chalmers Dies. Frank H. Stohr, general manager of the Allis-Chalmers Manufacturing Company's Norwood, Ohio works, died recently.

Western Electric Appointment. The Western Electric Company, manufacturing and supply unit of Bell Telephone Laboratories, has appointed Arthur B. Goetze as works manager of their Tonawanda plant, Buffalo, N. Y.; 42nd Street shops in New York, N. Y.; and the Allentown plant in Allentown, Pa. Mr. Goetze, who has been acting works manager of these plants, replaces William K. Wiggins, who will retire at the expiration of his present disability leave.

General Electric Appointments. R. T. Pennoyer has been appointed manager of the General Electric Company's Buffalo Tube Works, succeeding R. O. Poag, who died recently. S. W. Upham has been appointed to the post of sales manager of Army equipment in the Government division, at Electronics Park, Syracuse, N. Y. In the Wire and Cable Division of the Company's construction materials department, the following appointments have been made: Lyde E. Howard, sales manager of electric utility sales, with headquarters in Schenectady, N. Y.; James F. Farnam, sales manager, industrial and contractor sales, with headquarters at Bridgeport; Walter S. Hay, manager of transportation, federal, state and municipal sales, also at Bridgeport; John J. Curtin, manager, magnet wire sales, with headquarters at Schenectady, N. Y.; and Reginald B. McKinley, manager of commercial engineering, with headquarters in Bridgeport, Conn. Also at Bridgeport, Dr. Robert M. Lacy has been appointed staff assistant, responsible for the coordination of all laboratory activities of the General Electric Appliance and Merchandise department.

Copperweld Steel Elections. Maurice J. Mahoney has been elected secretary, and Charles A. Taylor, controller, of The Copperweld Steel Company, Glassport, Pa.

New Ward Leonard Office. The general office of the Ward Leonard Electric Company, Mount Vernon, N. Y., has been moved from the factory building at 31 South Street to a new office building at 115 South MacQueston Parkway, also in Mount Vernon. The new office includes executive and sales offices, and the company's headquarters for all operations.

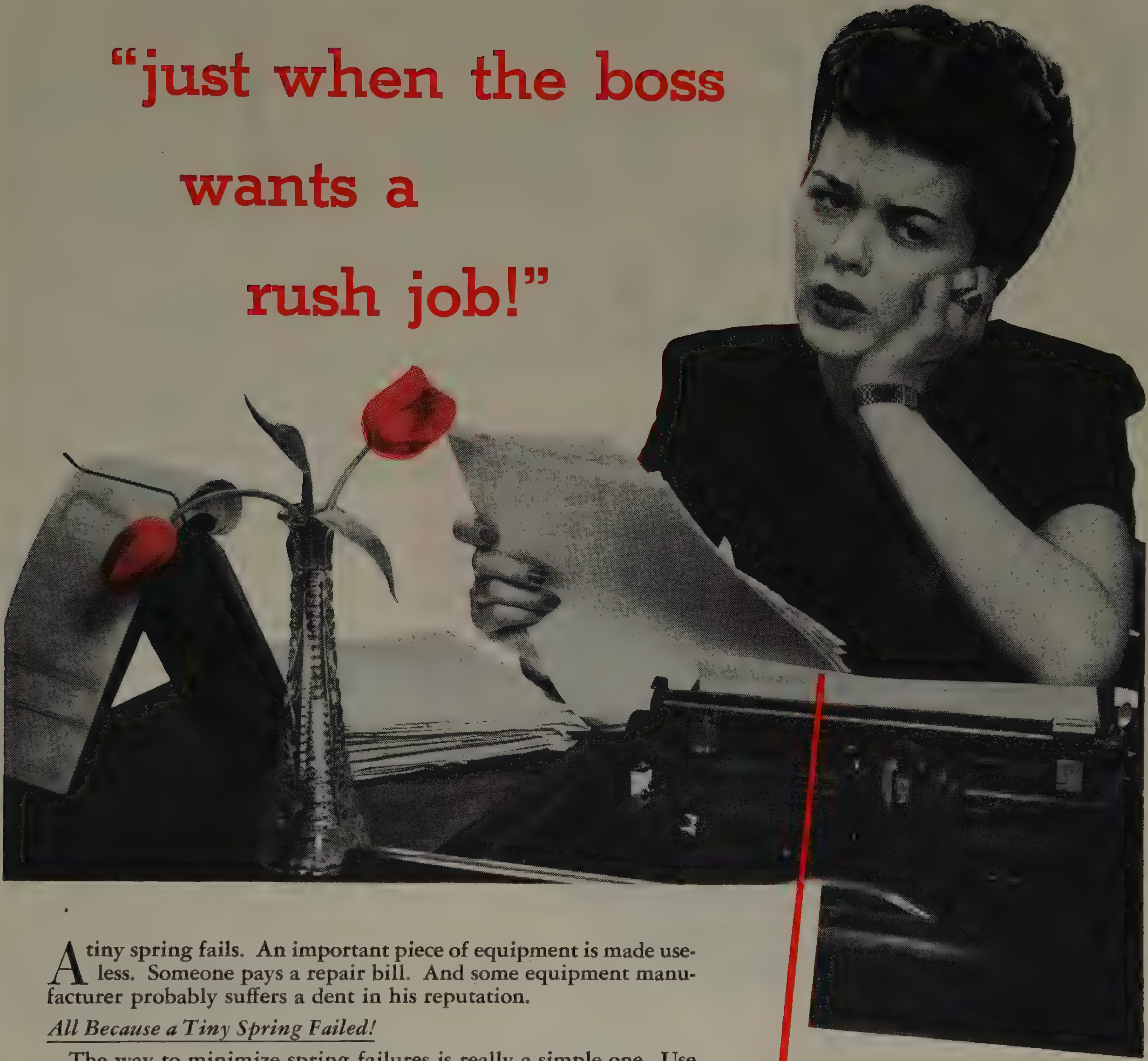
NEW PRODUCTS . . .

Weston Analyzer. The Weston Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, N. J., has developed a new analyzer designed for communication system maintenance. Model 779, type 5, makes decible per millivolt readings at all audio and carrier current frequencies. The a-c response is essentially flat to 50 kc within one decible over the range minus 20 to plus 22 decibles per millivolt, and is usable for comparative decible readings on all common carrier current frequencies above 50 kc. The instrument includes complete ranges to 1,000 volts alternating and direct current; direct current from 100 microamperes to ten amperes, resistance ranges from 1,000 ohms to 10 megohms, along with a transmission measuring instrument calibrated in one-half-decible steps. Further details are available from the manufacturer.

Molded Instrument Transformer by **G-E.** General Electric has announced an entirely new design of instrument current transformer, the "Butyl-molded" line. The 5,000 volt, 25–60 cycle indoor model, type *JKM-3*, will be available with single primary in all preferred ratings, 10 to 800 amperes inclusive. The butyl compound,

(*Continued on page 22A*)

"just when the boss wants a rush job!"



A tiny spring fails. An important piece of equipment is made useless. Someone pays a repair bill. And some equipment manufacturer probably suffers a dent in his reputation.

All Because a Tiny Spring Failed!

The way to minimize spring failures is really a simple one. Use the best spring wire to make small precision springs that actuate highly complicated mechanisms.

It has been the experience of many manufacturers of calculating machines, typewriters, cash registers and similar types of equipment that U·S·S Amerspring Music Wire is the best wire to use for quality spring making.

Amerspring Music Wire combines high tensile strength with unusual toughness. It has outstanding resistance to fatigue. And it has the stamina, resiliency, uniformity and freedom from defects that are imperative for top performance of small, precision springs.

So when springs are important to performance, remember—U·S·S Amerspring is the least expensive way to a superior performance.

This quality wire is available NOW for immediate delivery—in the mill quantities you need.

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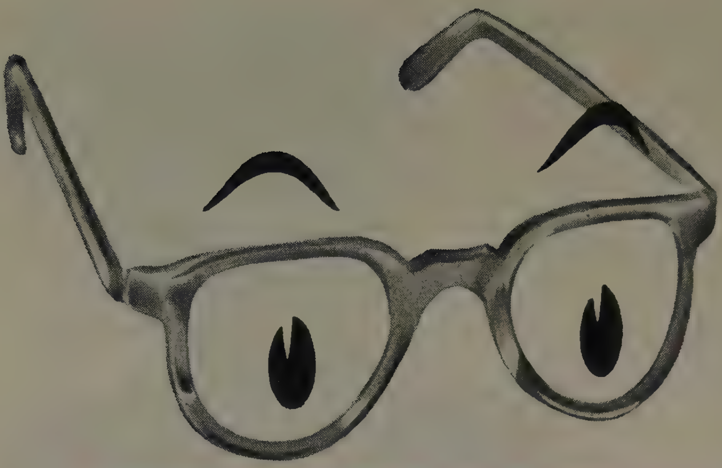
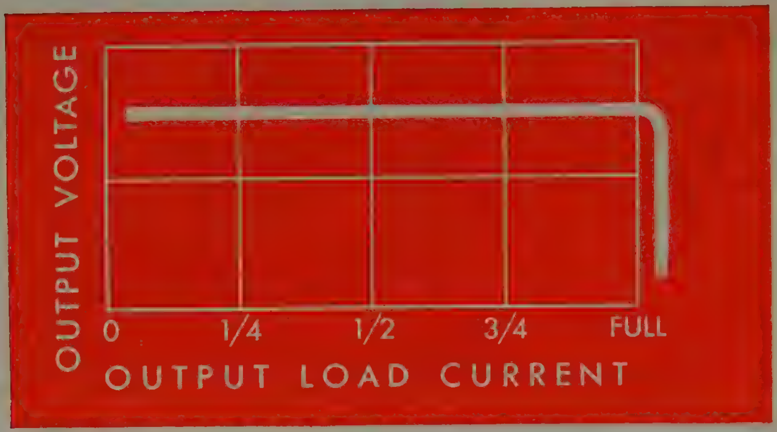
UNITED STATES STEEL





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Take another look at this regulation curve. It's smooth and flat over the entire load range . . . with automatic over-load protection through constant current control at any pre-set load. Graphically, it represents the precise control characteristics achieved by Power Equipment Company during its 14 years specialization in circuit development and design. And these characteristics, used singly or together, may readily and economically be applied to any product or process whose functions can be translated into electrical values. So if you've been looking for closer control and regulation . . . either for the equipment you make or for your production operations, why not get in touch with PECo engineers today? Chances are they already have what you need . . . and can give it to you fast.

Bulletin No. 848 describes and illustrates PECo research, engineering, and manufacturing facilities. Write for your copy today.

POWER EQUIPMENT Company

Specialists in Controlled Rectifiers Since 1935

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(*Continued from page 16A*)

injected under high pressure into all areas around the core, coils, and terminals, provides a homogenous insulation that has a high dielectric strength, resilient sturdiness, is oxidation, arc, and moisture-resistant, and assures permanent positioning of parts, even when subjected to high surge currents. Both primary and secondary coils are shaped like figure eight's for mechanical strength and accuracy—this special construction, and the intimate contact of the butyl with the windings provides increased heat dissipation, which permits continuous operation up to 150 per cent of rated load. An interleaved core construction eliminates any possibility of reduction of accuracy. Primary terminals are silver-plated to reduce contact resistance; secondary terminals are of the solderless clamp type. Further information is available from the General Electric Company, Schenectady 5, N. Y.

Voltage Regulator. Sorenson and Company, Inc., 375 Fairfield Avenue, Stamford, Conn., has just added a B-Nobatron to its line of voltage regulators. The new regulator is a highly-stabilized source of high voltage, low amperage direct current. Input voltage range is 105 to 125 volts a-c, 50–60 cycles. Additional information supplied upon request.

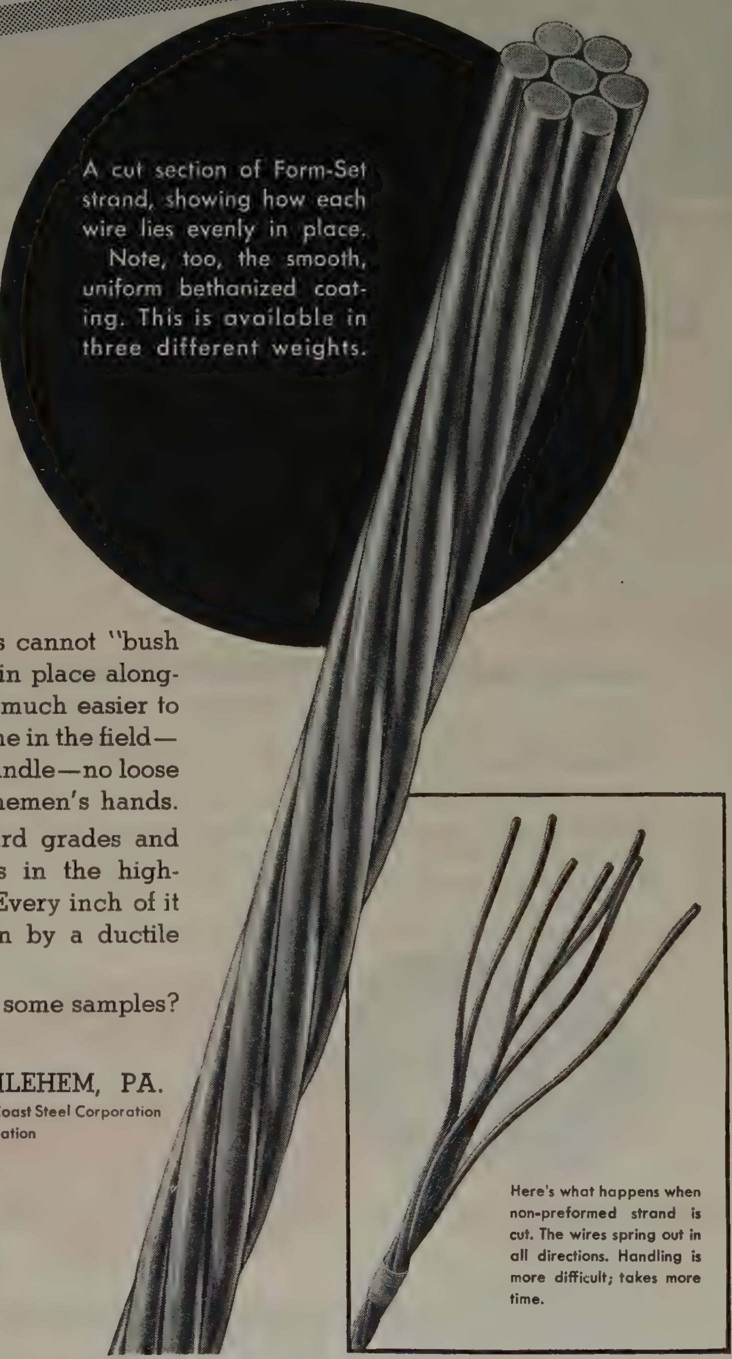
Radiation Meter. The Nucleonic Corporation of America, 497 Union Street, Brooklyn 31, N. Y., has produced a new type of portable survey meter, called a radiation meter, model RM-1. The meter has a continuously variable high voltage supply from 400 to 1,500 volts, permitting the use of end-window as well as cylindrical type GM tubes; a meter range covering 5,000, 50,000, and 500,000 counts per minute. At the upper range, more than four times tolerance dosage of X or gamma radiation can be measured. Further details may be obtained by writing directly to the company.

Dual Beam Oscilloscope. Beam Instruments Corporation, 55 West 42nd Street, New York 18, N. Y., has announced production of two new oscilloscope models manufactured by Cossor in England. Model 1035 features precision direct reading dial calibration of time intervals and amplitude for all gain and sweep switch positions, triggered sweep and 19 megacycle bandwidth. Model 1049 is similar, but features d-c amplification. Additional information upon request to the company.

Miniature Grid Bias Cell. P. R. Mallory and Company, Inc., Indianapolis, Ind., has developed a new type miniature grid bias cell, which provides a constant potential for bias of electronic tubes and circuits, where no current is required of the cell. The cell is available in two voltages, 1.5 and 1.75 volts. Since it is a potential device only, its electromotive force is lowered by even a fraction of a microampere drain; however, it is unaffected

(*Continued on page 30A*)

FORM-SET STRAND HAS *Extra* FEATURES THAT COST YOU ALMOST NOTHING!



A cut section of Form-Set strand, showing how each wire lies evenly in place. Note, too, the smooth, uniform bethanized coating. This is available in three different weights.

Here's what happens when non-preformed strand is cut. The wires spring out in all directions. Handling is more difficult; takes more time.

Bethlehem's preformed strand, known to the trade as Form-Set, has certain advantages that don't exist in the usual non-preformed type. Yet it sells for *very little* more than ordinary strand; the added cost is astonishingly low. Hence those extra features are yours for almost nothing.

What *are* the extra features? Here they are in a nutshell:

When Form-Set strand is cut, the wires cannot "bush out" or fly apart. Each wire lies placidly in place alongside its neighbors. This makes the strand much easier to handle; easier to insert in fittings. Saves time in the field—and temper, too. Also, it's much safer to handle—no loose wires sticking out to gouge or scratch linemen's hands.

Form-Set strand is made in all standard grades and sizes, but it is particularly advantageous in the high-strength and extra-high-strength grades. Every inch of it is bethanized—guarded against corrosion by a ductile zinc jacket applied electrolytically.

Why not let a Bethlehem man show you some samples? There's nothing like seeing for yourself!

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

480 VOLT TRANSFORMER BOX installation uses just one tape—"SCOTCH" No. 33 Electrical Tape—for fast, efficient job.

Do faster, better jobs with one-tape insulation

Try this new, fast method. Grab a roll of "SCOTCH" No. 33 Electrical Tape and get complete electrical insulation plus ample mechanical protection with this *one tape!*

Here's your chance to give this remarkable new "SCOTCH" Electrical Tape a try. Write us today asking for complete information and a *free* trial roll. Address: Dept. EN-6. No obligation.

Quick facts about "SCOTCH" No. 33 Electrical Tape

- **THIN CALIPER**—only .007 of an inch thick, takes less room in all insulation work.
- **HIGH DIELECTRIC**—insulates against charges of over 7,000 volts.
- **TOUGH**—plastic backing is abrasion resistant, unaffected by water, acids, alkalies, alcohols.
- **STRETCHY**—conforms snugly to uneven surfaces, odd shapes.

ANOTHER 3M COMPANY PRODUCT

Made in U.S.A. by
MINNESOTA MINING & MFG. CO. SAINT PAUL 6, MINN.
also makers of other "SCOTCH" Pressure-sensitive tapes, "UNDERSEAL," "SCOTCHLITE," "3M" Abrasives, "3M" Adhesives.
GENERAL EXPORT: DUREX ABRASIVES CORP., 240 NORTH AVE., NEW ROCHELLE, N. Y.
IN CANADA: CANADIAN DUREX ABRASIVES LTD., BRANTFORD, ONTARIO

(*Continued from page 22A*)

by alternating current of any frequency. At audio frequencies, the cells have a nonreactive impedance of between 250 and 1,500 ohms. For full details, contact the company.

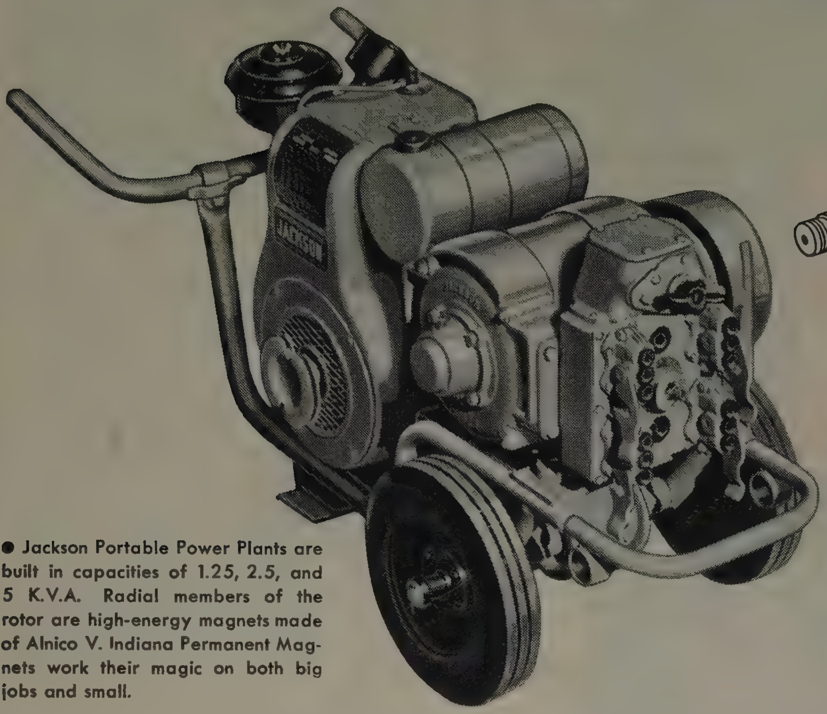
Pieper-Lillard Time Savers. Pieper-Lillard, Inc., St. Louis, Mo., has introduced a new P-L wire lay-up gin, which minimizes the time and labor consuming job of wire stringing, and a P-L universal wire-stringing pulley. The pulley can be used for pre-stressing and as a transformer gin as well, and is readily positioned by one man. Further information on both these products is obtainable upon written request to the company.

General Electric Developments. The tube division of the General Electric Company, Schenectady 5, N. Y., has announced two tube developments: 1. A new beam power amplifier tube, the *19BG6-G*, designed specifically for operation at high surge plate voltages for short periods, with a d-c plate voltage of 500 volts, and a d-c plate current of 100 milliamperes. Peak heater-cathode voltage is 250 volts with heater positive or negative in respect to cathode. 2. The *GL-5670*, a long-life miniature tube for mobile communication, is a high frequency twin triode, designed for sustained life under conditions of intermittent operation. Heater voltage on the tube is 6.3 volts, alternating current or direct current, while the heater current is 0.0350 amperes. Plate voltage is 300 volts, maximum. Further information on these new tube developments may be obtained from the Tube Division of the company. A new development at the special products division of the General Electric Company is the Beta-Ray Thickness Gage, which is designed to measure continuously the thickness of sheet materials moving along a conveyor without contacting or disturbing the material, by measuring the amount of beta-rays which are absorbed by the sheet material being checked. Operating on a power supply of 100–125 volts, 60 cycles, +0.3 cycles, power consumption of the gage is about 150 watts. Further information on the new gage may be acquired by writing to the special products division of the General Electric Company, Schenectady 5, N. Y.

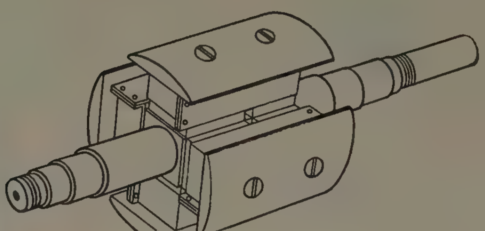
RCA Developments. The tube department of the Radio Corporation of America, Harrison, New Jersey, has announced several new developments—(1) An eight-inch PM speaker RCA-408S3, with a one-inch voice coil and a 6.8-ounce magnet, intended for use in television receivers and large table radios. It will handle eight watts. (2) A fixed-tuned, ultrahigh frequency oscillator triode, *5794*, with two integral resonators for use in radiosonde transmitters operating at 1,680 megacycles, and with a power output in the order of 500 milliwatts. One of the resonators is fixed-tuned and is attached between grid and cathode; the other is tunable over a

(*Continued on page 36A*)

THIS PERMANENT-MAGNET ROTOR MEANS RELIABLE ROUND-THE-CLOCK POWER



● Jackson Portable Power Plants are built in capacities of 1.25, 2.5, and 5 K.V.A. Radial members of the rotor are high-energy magnets made of Alnico V. Indiana Permanent Magnets work their magic on both big jobs and small.



121 FEWER PARTS . . .
LESS MAINTENANCE WITH
INDIANA
PERMANENT MAGNETS

121 fewer parts in a better, *more dependable* generator! That's what Indiana Permanent Magnets have done for Jackson Portable Power Plants. The rotor now is a permanent magnet field. There are no brushes or collector rings . . . no commutator sparking or arcing. Less heat is developed. Over-all size and costs are reduced. Maintenance is minimized. Here, again, modern design with Indiana Permanent Magnets is a *product plus* that pays.

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO!

For four decades, the pace-setting design techniques at Indiana have made possible *new and better* permanent magnets. And, on countless different products, this versatile "packaged energy" improves performance, permits new functions, saves space *and money* . . . as mechanical force in holders and separating devices . . . in transforming electrical energy into mechanical motion, and vice versa . . . in changing the apparent characteristics of materials. Indiana offers you the *experience and know-how* of more than 30,000 different applications. Let's get our engineers together on *your* problems. Write today.

Free Book for Designers

Ask for free Book No. 4-A6—our new permanent magnet reference manual. A note on your company letterhead will bring a copy to your desk.

INDIANA
PERMANENT
MAGNETS

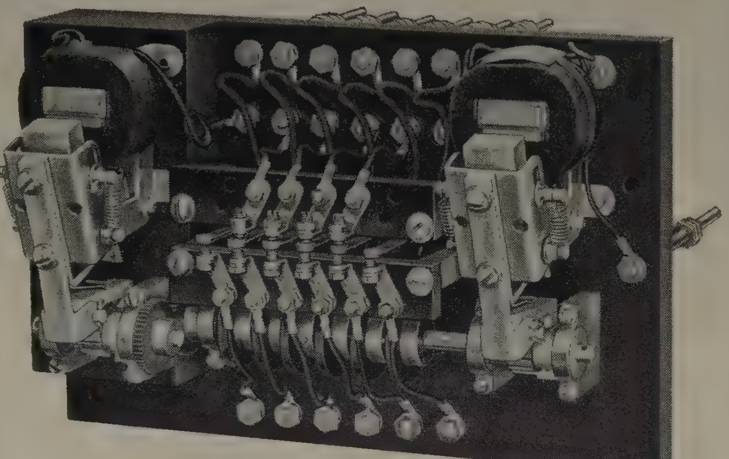
THE INDIANA STEEL PRODUCTS COMPANY
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS
SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

STANDARD RELAYS

. . . thousands of available types, electrically and mechanically adapted for every-day relay applications.

SPECIAL RELAYS

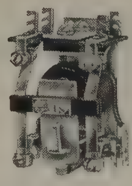
. . . types that have never been made before—for jobs that have never been done before.



BIG RELAYS OR LITTLE RELAYS

As specialists in relay design and manufacture, Struthers-Dunn has ranged from turning out 20,000 "production relays" a week to devoting a year for the development of a single highly-specialized type.

Twenty-seven years of experience in designing and building thousands of different relay types—for as many different applications—is available to help solve your relay problems.



Write for Catalog "G"—a quick, handy guide to the most widely used Struthers-Dunn relay types.

STRUTHERS-DUNN

STRUTHERS-DUNN, INC., 150 N. 13th Street, Philadelphia 7, Pa.

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DENVER • DETROIT • INDIANAPOLIS • KANSAS CITY • LOS ANGELES
MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PHILADELPHIA • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

(Continued from page 30A)

narrow range centering at 1,680 megacycles and is attached between grid and plate. (3) The *12S8-GT* multi-unit tube, combining three diodes and a high-mu triode in one bulb. It is designed to provide for the detection and amplification of either amplitude modulation or frequency modulation signals without switching detector circuits. (4) A 3-inch oscillograph tube, *3RPI*, with a high deflection sensitivity. It is capable of providing high brightness when operated with an anode number 2 voltage near the maximum of 2,500 volts and good brightness at relatively low anode number 2 voltages. The *3RPI* is intended for general oscillographic applications. It utilizes electrostatic deflection and electrostatic focus. Technical bulletins on all the above may be had by contacting the Tube Department, Radio Corporation of America, Harrison, N. J.

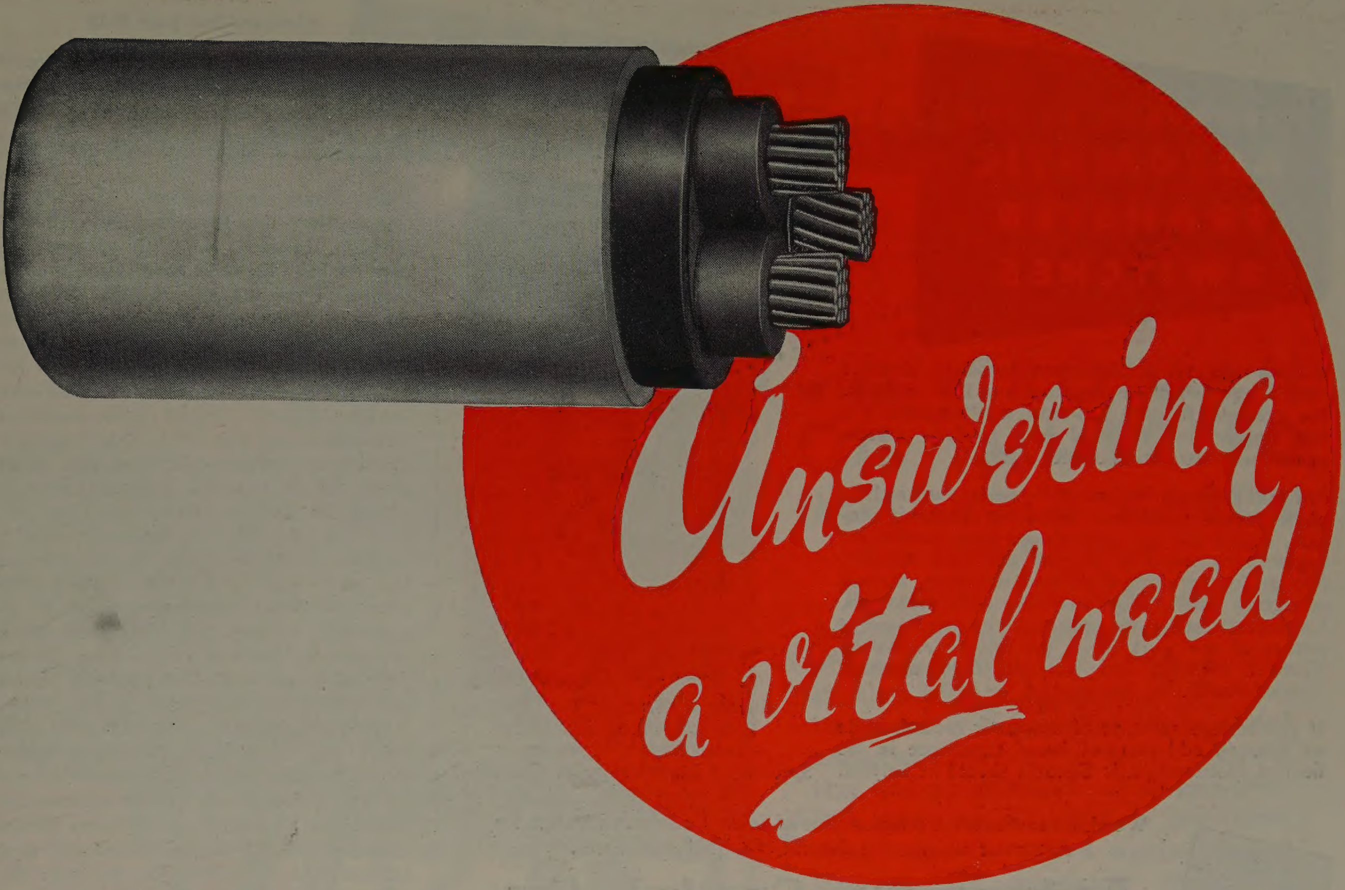
Wide Range Power Supply Apparatus. The special products division of the General Electric Company has developed a new wide range power supply apparatus which features a continuously variable voltage output from 500 to 50,000 volts with a maximum current output of one milliampere. Designed for laboratory applications where a variable voltage at low current is required, the high voltage of the wide range power supply is attained through the use of a radio frequency oscillator power amplifier, a radio frequency transformer, and a ladder-type voltage tripler circuit. Use of the radio frequency source, at about 40 kc, makes possible reduction of the output ripple to a low value by simple filtering means. There is a selection of two ranges: 500 to 5,000 volts and 5,000 to 50,000 volts. Power requirements are 100-130 volts rms, at 60 cycles, with commercial stability. Full power load consumption is about 1,000 watts. For additional information, write to the General Electric Company, Special Products Division, Schenectady 5, N. Y.

TRADE LITERATURE

New Vickers Catalogs. The Vickers Electric Division, Vickers, Inc., 1815 Locust Street, St. Louis 3, Mo., has just released two new catalogs: 1. Selenium Rectifier Catalog *VC-3000*, illustrating selenium rectifier characteristics, applications, design factors and price listings; 2. Photoelectric Cell Catalog *VC-4000*, illustrating self-generating photoelectric cell applications and design specifications. Both catalogs are available upon request.

Westinghouse Booklets. The Westinghouse Electric Corporation has issued two new bulletins—a 23-page booklet (*B-4112*) on Mot-o-Trol, a packaged electronic, adjustable speed drive for precise control of d-c motors operated from a-c sources, giving construction, maintenance, and application data; and a 20-page booklet (*B-3896*) which contains basic information

(Continued on page 42A)



SIMPLEX VARNISHED CAMBRIC CABLES

answer a vital need: the need for electric power cables that will stay on the job, providing unfailing service...

...WHERE OPERATING TEMPERATURES RUN HIGH

Simplex Varnished Cambric Cables can be operated at conductor temperatures as high as 85°C. depending on the operating voltage... have high current carrying capacity... assure long life at high ambient temperatures.

...WHERE CIRCUITS ARE EXPOSED TO MINERAL OIL

They are not harmed by immersion in mineral oil... are especially suited for use as transformer and oil switch leads, generator and motor leads in central stations and power houses.

...WHERE HEAVY LOADS ARE TRANSMITTED OVER SHORT DISTANCES

They can be relied upon for uninterrupted service where power at the higher voltages must be transmitted over short distances... are ideal for power circuits in industrial plants and mills.

...WHERE CIRCUITS ARE EXPOSED TO OZONE

They withstand exposure to ozone... assure trouble-free operation at the higher voltages.

Simplex Varnished Cambric Cables may have either rubber, lead, or braided coverings to meet the conditions where they are to be used. Special coverings are available to meet unusual service. The Simplex representative in your area will gladly show you where and how Simplex Varnished Cambric Cables can save money and serve you better.

SIMPLEX WIRES & CABLES

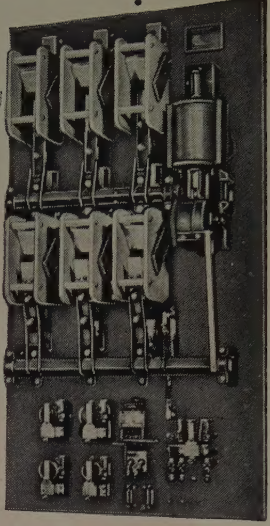
SIMPLEX WIRE & CABLE CO., 79 SIDNEY ST., CAMBRIDGE 39, MASS.

HEADQUARTERS FOR AUTOMATIC TRANSFER SWITCHES....

We can take care of almost any Automatic Transfer Switch requirement ranging from 5 to 1000 amperes. For example, Bulletin 906-105S, as illustrated, is a 300 ampere unit installed in a specially narrow panel for a distribution control center.

Standard features on control panels can include phase failure protection, indicating auxiliary contacts, engine starting contacts and push buttons for engine tests, reset to normal and load transfer. Special features include delayed operation, manual emergency handles, low frequency relay protection. Condensed Catalog No. 700 gives a comprehensive picture of our work along the line of Automatic Transfer Switches and complete Electromagnetic Control Panels.

If you require any type of automatic control, write us. Our 60 odd years of broad experience in the field of Electromagnetic Controls should be helpful.



Automatic Transfer Switches
Remote Control Switches
Contactors Relays
Specialized Electromagnetic Controls

We also manufacture a complete line of Solenoid Operated Valves for Automatic and Remote Control of Liquids and Gases.

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.
385-E LAKESIDE AVENUE · ORANGE, NEW JERSEY

MEASUREMENTS CORPORATION

Peak-to-Peak VOLTMETER

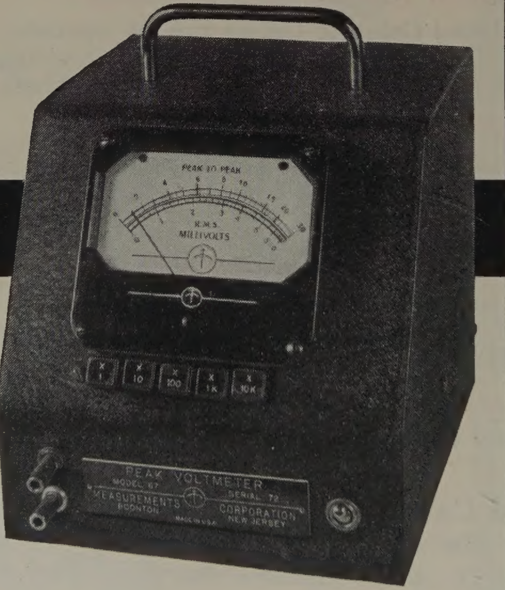
.0005—300 VOLTS

MODEL 67

Designed for accurate indication of the peak-to-peak values of symmetrical and asymmetrical waveforms, varying from low frequency square waves to pulses of less than five microseconds duration.

.0005-300 volts peak-to-peak, .0002-100 volts r. m. s. in five ranges. Semi-logarithmic, hand calibrated scales.

Provision for connection to 1500 ohm, 1 milliampere graphic recorder or milliammeter.



INPUT IMPEDANCE: 1 megohm shunted by 30 mmfd.
DIMENSIONS: Height 7½", width 7", depth 8½". Weight 8 lbs.
POWER SUPPLY: 117 volts, 50-60 cycles, 35 watts.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

(*Continued from page 36A*)

on Type *E* industrial turbines. Copies of the above are available by writing to the Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

RCA Tube Information. The Radio Corporation of America, RCA Victor Division, Harrison, N. J., has released four new booklets on their new tube developments. Technical bulletin *4-65A* describes the RCA *4-65A* very high frequency power tetrode, which has a maximum plate dissipation of 65 watts, intended for modulator, power amplifier, and oscillator service. Bulletin *16AP4* gives technical information on the RCA *16AP4* 16-inch metal-cone picture tube (the first of its kind), which provides a picture area of 132 square inches. Along with this technical bulletin, RCA has also published a booklet, "RCA Television Components for Kinescope RCA *16AP4* Form CTV-1004, which includes characteristics and dimensional outlines for 18 RCA television components for use in receiver designs employing the new picture tube. Circuit information for the *16AP4* is also given. Technical bulletin *5763* describes the RCA *5763* very high frequency power amplifier of the nine-pin miniature type for use in low-power mobile transmitters and stages of higher-power, fixed station transmitters. All the above literature may be obtained by writing to the tube department of the Radio Corporation of America.

A. B. Chance Tips. The A. B. Chance Company of 210 North Allen Street, Centralia, Mo., publishes a house organ, "Chance Tips," which contains illustrated articles of special interest to the electrical industry. Volume II, number 1, contains articles on care of hot line tools and short circuit tests. Also available is the new A. B. Chance catalog, a seven ring looseleaf binder, which contains 19 indexed sections on all Chance products. Copies obtainable upon request to the company.

IRC Insulated Chokes Bulletin. The International Resistance Company, 401 Broad Street, Philadelphia 8, Pa., has issued a four-page technical data bulletin (*H-1*) which describes the new radio-frequency IRC chokes specially designed for television and frequency modulation receiver requirements. Copies available upon request to the company.

Du Pont Neoprene Notebooks. The rubber chemicals division of the E. I. Du Pont de Nemours and Company, Inc., Wilmington, Del. has published two new issues of the Neoprene Notebook—volume 42 which contains complete information on Neoprene adhesives, and a separate Neoprene Notebook Index, which contains an index of former issues 1 to 42, inclusive. Copies of these booklets are obtainable upon written request to the company.

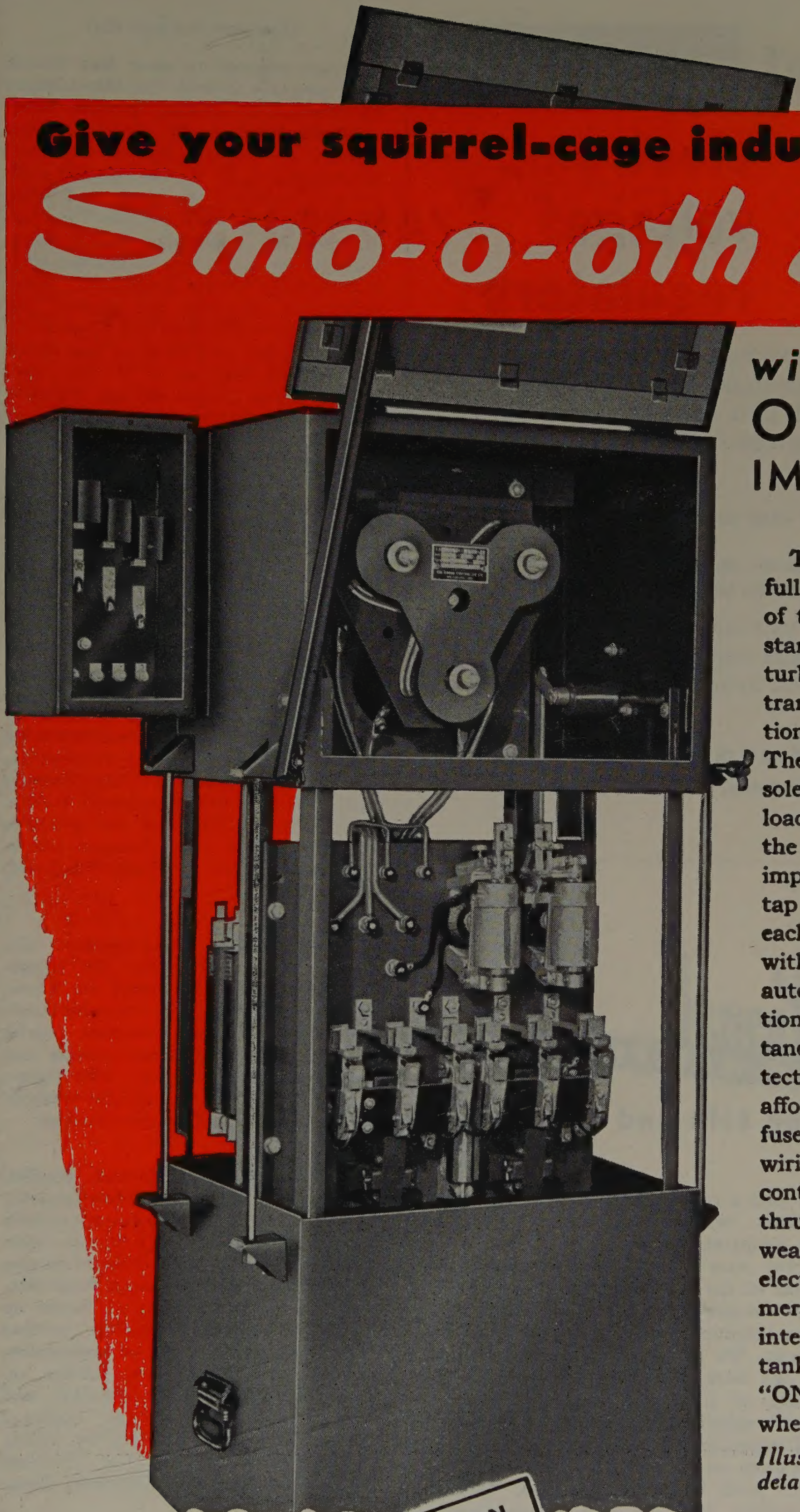
General Electric Publications. As part of a new "More Power to America"

(*Continued on page 54A*)

Give your squirrel-cage induction motors a Smo-o-oth Start

with a ROWAN OIL IMMERSED IMPEDANCE STARTER

(Type 900 Series)

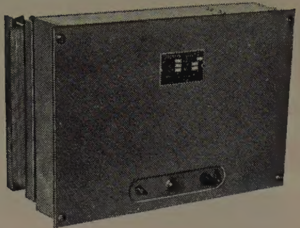


This Rowan push button operated, fully automatic, reduced voltage starter of the impedance type, assures smooth starting with a minimum of line disturbance. It is a starter of the closed transition type utilizing for its acceleration, a combination of current and time. The acceleration period is dependent solely upon the driven equipment and load—thereby completely eliminating the human element. Continuous wound impedance coil assures freedom from tap failures—impedance is adjustable to each application. The unit is equipped with magnetic overload relays with automatic reset, providing a combination of inverse time element and instantaneous operation and single phase protection. Short circuit protection is afforded by time-tested Rowan Air-Seal fuses. It has a sealed-off, centralized wiring compartment for load line and control leads and provision for straight thru conduits. Enclosure is of the weather-resistant, dust-tight type. All electrical operating parts are oil immersed and the tank is mechanically interlocked to prevent lowering of the tank when the safety switch is in the "ON" position, or closing the switch when the tank is lowered.

Illustrated circular containing complete details is available upon request.

TYPE 900 KBF COMBINATION
Reduced Voltage Starter of the Impedance Type for use on 3 ph., 600 V service or less. Also available in 950 series for 2300 V., 3 ph., service.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.



the first line of standard electronic voltage regulators

Only Sorensen electronic voltage regulators offer as much as 0.1% regulation accuracy under SIMULTANEOUS line and load changes.

SIX IMPORTANT SORENSEN FEATURES:

1. Precise regulation accuracy;
2. Excellent wave form;
3. Output regulation over wide input voltage range;
4. Fast recovery time;
5. Adjustable output voltage, that once set, remains constant;
6. Insensitivity to line frequency fluctuations between 50 and 60 cycles.

The Sorensen Catalog contains complete specifications on standard voltage regulators and nobatrons. It will be sent to you upon request.

SORENSEN and company, inc.
375 fairfield avenue, stamford, connecticut

Specify National INSULATING MATERIALS
For Long Life and Reliability

Adhesives
Cements
Compounds
Enamels
Fabrics
Fiberglas
Laminates
Mica Products
Papers, Fibres
Silicones
Sleevings
Tapes
Tubings
Varnishes

If you have a *special* electrical insulation problem — heat, moisture, oil, acid, etc. — which causes persistent trouble — *that's* where we shine. For years and years we have studied the problems of the man who has more than the ordinary insulation problem. We have found ways to lengthen insulation life under adverse conditions. We developed Mica-Glas, all-inorganic. We were among the first to apply the advantages of silicone to insulation. Then, to bring such experience to you we placed factory-trained engineers in the field. One is near you *now*, waiting not just to sell insulation but to help you profit by its use. Use him. Tell him your problem. He's equipped to solve insulation problems, and that's his job. Call him in; if you don't know him, write or wire us.

NATIONAL ELECTRIC COIL COMPANY
COLUMBUS 16, OHIO, U. S. A.
ELECTRICAL ENGINEERS. MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES
TRADE MARK

(*Continued from page 42A*)

program designed to show how electric heat, properly applied, can help industry to increase production, provide better equipment designs, and improve product quality, the General Electric Company, Schenectady 5, N. Y., has released a 25-minute, 35-millimeter black and white sound slide-film, "Heat—Where You Want It," and five application data booklets, covering the major uses of tubular, strip, and cartridge heaters in industry. Those desiring to purchase the program kit, including the slide-film and 50 copies of each of the five data booklets, may obtain it for $15.00 from any of the company's district offices. Those desiring copies of the booklets only, may obtain them free of charge by writing to the General Electric Company at Schenectady 5, N. Y. Another recently issued booklet, "87 Welding Ideas for the Modern Farmer" is also available from General Electric at Schenectady. Listed as publication *GEA-5053*, the 24-page booklet shows what can and is being done with welding by progressive farmers throughout the country.

Allis-Chalmers Booklet. Construction features of Allis-Chalmers metal-enclosed low-voltage switchgear and drawout air circuit breakers have been described in an eight-page booklet recently released by the company. Copies of "Allis-Chalmers Low Voltage Metal-Enclosed Switchgear," bulletin *18B6376A*, are available upon request to Allis Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

General Radio Experimenter. The General Radio Company, 275 Massachusetts Avenue, Cambridge 39, Mass., issues a monthly booklet, "General Radio Experimenter," which contains articles concerning electrical measurements and their industrial application. The 8-page, illustrated booklet is available without charge upon request to the company.

Trumbull Magnetic Control Booklet. The Trumbull Electric Manufacturing Company has issued a new 22-page bulletin announcing a new line of magnetic motor control, which has been designed to give full protection against damage from overload and under voltage to a-c motors up to 50 horsepower. Complete product data is given on types of disconnects, reversing and non-reversing starters, reversing and non-reversing contactors, and combination magnetic starters. Copies of the booklet may be obtained by writing for bulletin *TEB 8*, to The Trumbull Electric Manufacturing Company, Plainville, Conn.

Struthers-Dunn "Quick-Guide" Catalog. A simplified listing of essential data to permit easy selection from the hundreds of the most widely used relays produced by Struthers-Dunn Inc., has just been published. The relays are classified according to their function, making selection simple. A copy of the catalog may be obtained by writing to Struthers-Dunn Inc., 150 North 13th Street, Philadelphia, Pa.